An account of the Ordovician rocks of the Shelve Inlier in west Salop and part of north Powys

The late **W. F. Whittard,** F.R.S.
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Synopsis

On the basis of the late Professor W. F. Whittard's field maps and notes, a geological map, scale 1 : 32 000, is presented for the Ordovician rocks of the Shelve Inlier. These strata, excluding the Shineton (or Habberley) Shales of Tremadoc age, range from lower Arenig Series to lower Caradoc Series. The history of the lithostratigraphic classification is reviewed, and a scheme of three formations and fifteen members proposed on the basis of already-named subdivisions. Descriptions are accompanied by enlarged sketch maps showing outcrops and relevant fossil localities. A slightly revised correlation table is included, together with a table showing characteristic trilobites. Geological structure and igneous rocks (all known outcrops of which are shown on the map) are briefly discussed.

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The late Professor W. F. Whittard, F.R.S.
1902–1966

Introduction and Acknowledgements

The task of mapping and describing the Ordovician rocks and faunas of the Shelve Inlier was begun by Professor W. F. Whittard (frontispiece) in 1930 as a sequel to work on the Lower Silurian rocks of the same area. From then until his untimely death early in 1966 the Shelve Inlier occupied the greater part of his research time and was frequently visited by him with mapping classes from the University of Bristol. Although the Ordovician rocks of the Inlier have yielded large numbers of fossils – and Whittard's beautiful monograph (1955) on the trilobites, published by the Palaeontographical Society, is a classic of its kind – they are rarely obviously fossiliferous to the casual visitor, who may find collecting both difficult and unrewarding. Much of Whittard's time on the Inlier, particularly during the early years, was spent collecting fossils in an attempt to define the faunal content of the numerous lithostratigraphic subdivisions established earlier, principally by Lapworth & Watts (1894), and it was not until the appointment of Mr T. R. Fry as Whittard's research assistant that the time-consuming task of fossil-collecting was eased. Fry displayed a remarkable aptitude for obtaining faunas from even the most unpromising strata and his contribution received appropriate recognition when the University of Bristol awarded him the honorary degree of M.Sc. in 1970. In later years he was ably assisted by Mr M. White and both had trilobite species named after them by Whittard.

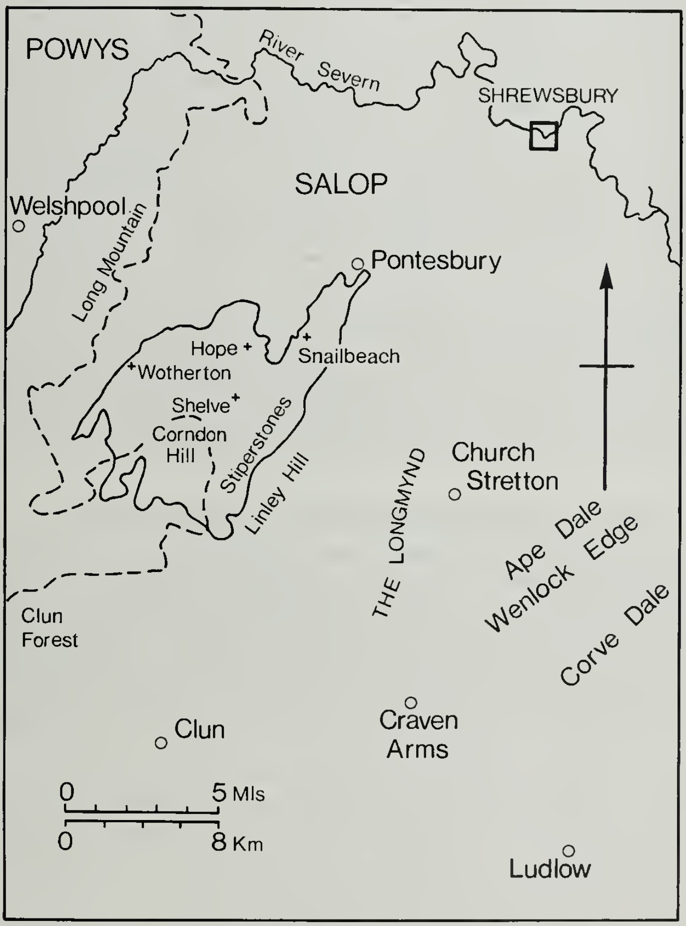

Fig. 1 Sketch map of part of the Welsh Borderland showing the position of the Shelve Inlier in relation to various towns and topographic features.

Whittard's mapping of the Ordovician rocks in the Shelve Inlier formed a natural sequel to his well-known mapping and highly original interpretation of the Lower Silurian strata of the region. He noted that the lack of cleavage affecting the Ordovician rocks, together with their relatively abundant fossils, not always readily apparent during brief visits, showed the palaeontological promise to be much greater than previously published accounts might have led one to believe. Furthermore, the rich trinucleid trilobite faunas suggested to him that the Shelve succession might become the standard for the Lower and Middle Ordovician of the Anglo-Welsh area, a sentiment expressed earlier with equal confidence by Lapworth (1887 : 663), while the not infrequent intermixing of shelly fossils and graptolites held out hope for the solution of numerous correlation problems.

At the time of Professor Whittard's death the Shelve trilobite monograph was almost complete, lacking only a final chapter (since completed, Dean 1967) on the affinities of the trilobites; more recently the brachiopods have been described by Williams (1974) and the graptolites are being studied by Dr Isles Strachan. A large proportion of the mapping had been completed at a scale of 6 in to 1 mile (1 : 10 560) and the results entered upon Quarter-Sheets mounted on cloth. Unfortunately several gaps remained on this version of the geological map, particularly in complex areas where more than one interpretation is possible, and it has been my object to try to fill these gaps utilizing Whittard's field slips, some of which are at a scale of 25 in to 1 mile (1 : 2534·4). No systematic account of the Shelve Inlier's geology had been prepared but notes on a large number of Ordovician localities are contained in Whittard's meticulous field notebooks and I have drawn extensively upon these in preparing the Ordovician stratigraphic account. Consequently most of the geological observations and conclusions in the present paper are attributable to Professor Whittard but in addition numerous publications are quoted in an attempt to formulate a coherent account of the Inlier, and any shortcomings in drawing the two sets of data together are my own responsibility. It had clearly been Whittard's intention to make his description of the Shelve Inlier as comprehensive as possible, including chapters on geological structure, igneous activity and mineralization, but as no such accounts had been prepared I have preferred to keep these sections to a minimum.

All the measurements are given in British Imperial units, as originally made by Whittard; metric equivalents are appended in every case.

The small geological maps reproduced as figures in the text are at a scale of 4 in to 1 mile (1: 15 840); grid squares are indicated. The photographs are from colour transparencies taken by Whittard; all the places named may be found with reference to points shown in the large Map.

The numbered localities refer to Whittard's manuscript notes.

Geographical location and Previous researches

The Ordovician rocks of the Shelve Inlier form an irregular area (Fig. 1) of some 43 mile^2 (111 km^2) centred approximately on Shelve, an otherwise obscure hamlet situated *c.* 21 km (13 miles) SW of Shrewsbury. Most of the inlier is located within the bounds of west Salop (formerly Shropshire), but the area in the south-west, comprising Corndon Hill, Todleth Hill and Church Stoke (Fig. 2), forms part of the adjacent Welsh county of Powys. Topographically the area is one of rapidly-changing relief, drained by the Rivers Camlad and West Onny together with numerous streams which exhibit a suggestion of a radial pattern. The highest points are found at Corndon Hill (1683 ft, =513 m) and the Stiperstones (up to 1762 ft, =537 m), the latter bounding the sombre, marshy area of The Bog and forming an impressive rampart which achieved some literary recognition in Mary Webb's novel 'Gone to Earth'. The region is sparsely inhabited and villages and hamlets are relatively few, the most notable being Chirbury, Hope, Old Church Stoke, Priestweston, Rorrington and Wotherton. In Roman times the area around Shelve and Ritton Castle was the site of important lead mines and lead mining continued until early in the 20th century; it has since been discontinued but exploitation of barytes in the old tip heaps continues sporadically at the present day. Notable view-points are Bromlow Callow (Map) and the top of Priest Weston Bank from which can be seen a panorama that includes Plynlimmon,

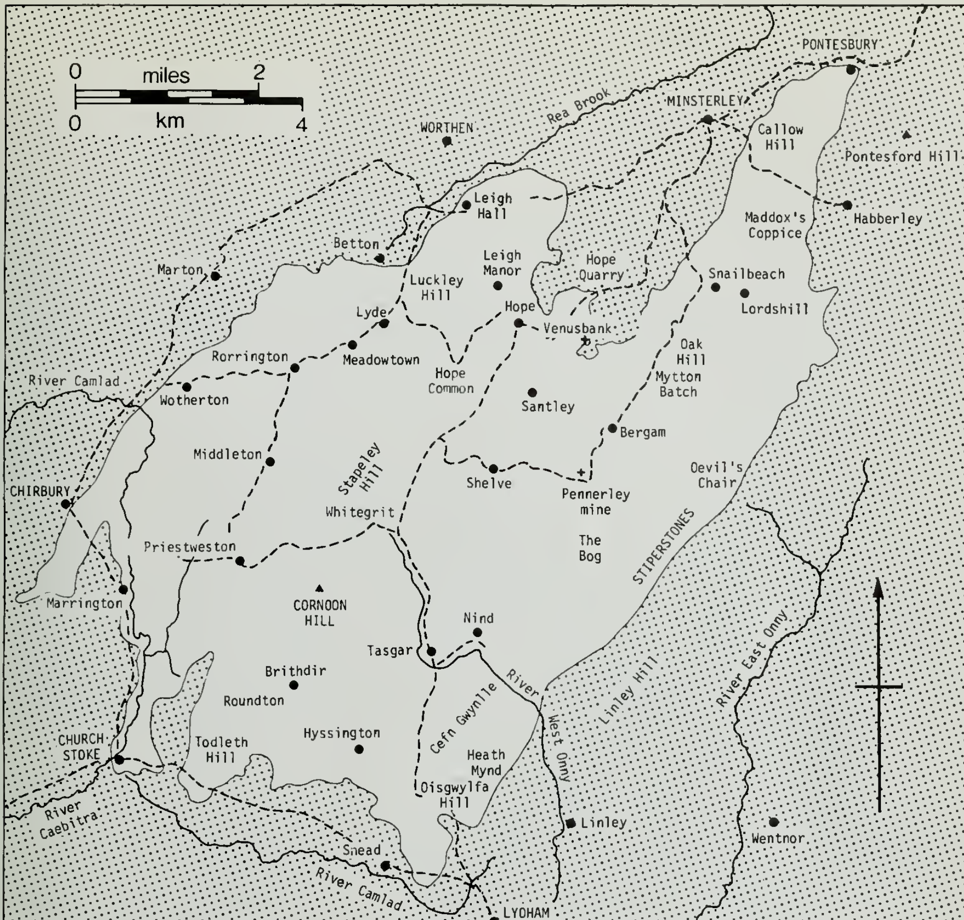

Fig. 2 Outline map of the Shelve Inlier to show the location of principal place-names mentioned in the text.

Cader Idris, the twin Peaks of the Arenigs, Berwyn and, to the north, the Cheshire Plain with its girdle of Bunter Sandstone (Trias) hills such as Grinshill, Hawkstone and Nesscliff. From the Stiperstones all these are visible and, in addition, the Uriconian hills of the Church Stretton area showing over the top of the Longmynd, the isolated Uriconian mass of the Wrekin to the north, and the successive Silurian escarpments running away from view to the south.

Work on the Ordovician rocks of the Inlier dates from the time of Murchison and a brief chronicle of subsequent researches was given by Whittard (1931 : 332; 1952) and, with particular reference to the trilobites, in the first part of his monograph (1955 : 1). As he noted, the first geological maps of the region were provided at a scale of 1 in to 1 mile (1 : 63 360), although a detailed 6 in to 1 mile (1 : 10 560) map by Lapworth & Watts remained unpublished except for a reduced and 'slightly modified' version which appeared in the Geological Survey's regional guide to the Welsh Borderland (Pocock & Whitehead 1948 : pl. 11; Earp & Hains 1971 : pl. 4). The frequent alternation of resistant bands of the Whittery, Hagley and Stapeley Volcanic Members, and quartzites of the Stiperstones Member, with soft shaly bands that are also often present within the volcanics themselves, gives rise to a ribbed topography which quickly shows any displacement caused by faulting. The innumerable breaks in the run of these hard rocks, associated

LAPWORTH, 1887

Marrington Group	Whittery Ashes & overlying shales
Marrington Group	Hagley Volcanic Ashes & Shales
Aldress Group	Aldress Graptolitic Shale
Aldress Group	Spy Wood Calcareous Grit
Rorrington Group	
Middleton Group	
Weston Group	
Stapeley Volcanic Group	
Ladywell Group	
Stiper Group	
Cambrian	

LAPWORTH & WATTS, 1894

Chirbury Series	Marrington Group	Whittery Shales
Chirbury Series	Marrington Group	Whittery Ash
Chirbury Series	Marrington Group	Hagley Shales
Chirbury Series	Marrington Group	Hagley Ash
Chirbury Series	Spy Wood Gp	Aldress Graptolitic Shale
Chirbury Series	Spy Wood Gp	Spy Wood Grit
Meadowtown Series	Rorrington Flags	
Meadowtown Series	Middleton Group	
Meadowtown Series	Weston Group	
Shelve Series	Stapeley Ashes	
Shelve Series	Hope Shale Group	
Shelve Series	Mytton Group	
Shelve Series	Stiper Stones Quartzite	
Shineton Shales		

LAPWORTH & WATTS, 1910

Chirbury Series	Marrington Group	Whittery Shale
Chirbury Series	Marrington Group	Whittery Ash
Chirbury Series	Marrington Group	Hagley Shale
Chirbury Series	Marrington Group	Hagley Ash
Chirbury Series	Spy Wood Gp	Aldress Shale
Chirbury Series	Spy Wood Gp	Spy Wood Grit
Middleton Series	Rorrington Shales	
Middleton Series	Meadowtown Calcareous Beds or Stage	
Middleton Series	Betton or D. murchisoni Shales	
Middleton Series	Weston Flags & Shales	
Shelve Series	Stapeley Ashes	
Shelve Series	Hope Shales	
Shelve Series	Mytton Flags	
Shelve Series	Stiper Quartzite	
Shineton Shales (conformable)		

LAPWORTH, 1916

Chirbury Series	Marrn Group	Marrington or Whittery Shales
Chirbury Series	Hagley Group	Whittery Ash
Chirbury Series	Hagley Group	Hagley Shales
Chirbury Series	Hagley Group	Hagley Ash
Chirbury Series	Aldress Group	Dictyonema Band, L. sericea Bands, Climaco. & Dicrano. Beds, Beyrichia Grits
Middleton Series	Rorrington Gp	Leptograptus Beds
Middleton Series	Rorrington Gp	Nemagraptus Beds
Middleton Series	Meadowtown Gp	Ogygia Shales (Mount Beds)
Middleton Series	Meadowtown Gp	Meadowtown Lst, Flags Ogygia Flags
Middleton Series	Betton Gp	Didymograptus murchisoni Beds
Middleton Series	Weston Gp	L. & U. Weston Grits Weston Shales
Shelve Series	Stapeley Group	Upper Stapeley Shales
Shelve Series	Stapeley Group	L, M & U Ashes L & M Shales
Shelve Series	Hope Gp.	L, M & U Hope Shales & Chinastone Ash
Shelve Series	Mytton Group	Tankerville Flags & Shales
Shelve Series	Mytton Group	Ladywell, Snailbeach Sh., Lord's Hill Beds
Shelve Series	Mytton Group	Stiper Stones (Quartzite)
		Habberley Shales (conformable)

WATTS, 1925

Chirbury Series	Marrn Stage	Whittery Shales
Chirbury Series	Hagley Stage	Whittery Ash
Chirbury Series	Hagley Stage	Hagley Shales
Chirbury Series	Hagley Stage	Hagley Ash
Chirbury Series	Aldress Stage	Shales with Dictyonema, etc
Chirbury Series	Aldress Stage	Beyrichia Grit
Middleton Series	Rorr'n Stage	Leptograptus Beds Nemagraptus Beds
Middleton Series	M'town Stage	Ogygia Shales Lsts & Flags Ogygia & Asaphus Flags
Middleton Series	Betton St	D. murchisoni Beds
Middleton Series	Weston St	Grits & Shale
Shelve Series	Stapeley Stage	Alternating sequence of 3 lavas and 3 shales
Shelve Series	Hope Stage	L, M & U Shales & Chinastones
Shelve Series	Mytton Stage	Tankerville Flags
Shelve Series	Mytton Stage	Shelve Church Beds, etc.
Shelve Series	Mytton Stage	Stiperstones Quartzite
Habberley Shales (conformable)		

Fig. 3 Series of tables showing the progressive development in Ordovician

with high dips approaching the vertical, soon demonstrated that the inlier is traversed by tear-faults which, in the present paper, are shown to possess a remarkably uniform pattern. Whittard's notes emphasize that most of these tear-faults, which constitute such a dominant structural feature of the inlier and were reviewed by him (Whittard 1952 : 186, *et seqq.*), had not been recognized by Lapworth & Watts. A point reiterated in the notes is that such structures could only be mapped satisfactorily on the basis of a detailed knowledge of the stratigraphical palaeontology, so that it became possible to differentiate between sets of outcrops which, although lithologically distinct (and therefore true lithostratigraphic subdivisions) when clear sections were available, nevertheless posed considerable problems of identification when seen only in the form of small, weathered outcrops of shattered rock.

Geologically the inlier is bounded on the east by the Pre-Cambrian (Western Uriconian and Longmyndian) rocks of the Longmynd and adjacent areas, which are separated from the Shineton Shales of the Habberley Valley by a major structural line, the Linley–Pontesford Fault. The latter was not shown on Whittard's manuscript map but for the sake of giving a more complete geological picture is included here together with certain details of the Linley and Pontesford districts taken from papers by James (1956) and by Dean & Dineley (1961). The southern boundary is formed by the overstep at the base of the unconformable Lower Silurian

WHITTARD, 1931		WHITTARD, 1940	WHITTARD, 1952	WHITTARD, 1955		WHITTARD, 1966	PRESENT PAPER	
Marrington St.	Whittery Shales	Whittery Shales	Whittery Shales	Whittery Shales with Volcanic Gp.		Whittery Shales	CHIRBURY FORMATION	Whittery Shale Member
Hagley Stage	Whittery Volcanic Group	Whittery Volcanic Gp.	Whittery Volcanic Gp.			Whittery Volcanic Gp.		Whittery Volcanic Member
	Hagley Shales	Hagley Shales	Hagley Shales	Hagley Shales and Volcanic Gp.		Hagley Shales		Hagley Shale Member
	Hagley Volcanic Group	Hagley Volcanic Gp	Hagley Volcanic Gp			Hagley Volcanic Gp		Hagley Volcanic Member
Aldress Stage	Aldress Shales	Aldress Shales	Aldress Shales	Aldress Shales		Aldress Shales		Aldress Member
	Spy Wood Grit	Spy Wood Grit	Spy Wood Grit	Spy Wood Grit		Spy Wood Grit		Spy Wood Member
Rorrington Stage	Rorrington Beds	Rorrington Beds	Rorrington Beds	Rorrington Beds		Rorrington Beds	MIDDLETON FORMATION	Rorrington Member
Meadowtown Stage	Meadowtown Beds	Meadowtown Beds	Meadowtown Beds	Meadowtown Beds		Meadowtown Beds		Meadowtown Member
Betton Stage	Betton Beds	Betton Beds	Betton Beds	Betton Beds		Betton Beds		Betton Member
Weston Stage	Weston Grits & Flags	Weston Beds	Weston Beds	Weston Beds		Weston Beds		Weston Member
Stapeley Stage	Stapeley Shales	Stapeley Shales	Stapeley Shales	Stapeley Shales		Stapeley Shales	SHELVE FORMATION	Stapeley Shale Member
	Stapeley Volcanic Group	Stapeley Volcanic Gp	Stapeley Volcanic Gp	Stapeley Volcanic Gp		Stapeley Volcanic Gp		Stapeley Volcanic Member
Hope Stage	Hope Shales & Chinastone Ash	Hope Shales	Hope Shales	Hope Shales with Chinastone Ash		Hope Shales		Hope Member
Mytton Stage	Mytton Flags	Mytton Flags	Mytton Flags	Mytton Flags	Tankerville Flags	Tankerville Flags		Mytton Member
					Shelve Church & Lord's Hill Beds	Mytton Flags		
	Stiperstones Quartzite	Stiperstones Quartzite	Stiperstones Quartzite	Stiperstones Quartzite		Stiperstones Quartzite		Stiperstones Member
Habberley Shales		Habberley Shales	Tremadocian	Habberley Shales		Habberley Shales	Shineton Shales	

ithostratigraphic terminology for the Shelve Inlier from 1887 to the present.

rocks. Similar Silurian strata form the northern boundary but extend farther across the Ordovician outcrop and are in turn overstepped by the unconformable base of the Coal Measures of the Hanwood Coalfield. The relationships of these overlying Silurian and Carboniferous rocks are much obscured by glacial deposits and by alluvium of Habberley Brook, River West Onny, River Camlad, and Aylesford and Rea Brooks. The western boundary of the inlier is still more obscured and it is possible that additional, and younger, Ordovician strata may underlie the cover of superficial deposits. Whittard's unpublished notes on this area include the following paragraphs:

Excluding the exposures of Hagley Shales in the village of Church Stoke, there are no localities on the west of the Church Stoke – Chirbury road and south of the road from Alport to Cross House, Rhiston and Upper Grwarhlow where any solid rock can be examined. Much of this area is about 500 ft (152 m) O.D. and topographically it is composed of an eastward-trending ridge which is aligned at right-angles to any known strike in the Ordovician rocks or expected strike in the Silurian rocks, and since there is much boulder-clay over the region, this feature and the absence of solid exposures can reasonably be attributed to a thick glacial accumulation; this may be morainic in origin and may be associated with the mass of ice which led to the formation of the Marrington Dingle overflow channel.

In one field two wells have been dug near Whitepits and both provided glacial lake clays and some boulder-clay; the depth of one well was 36 ft (11 m) and solid rock had not been reached. Trial holes dug to the north and south-west at Poundbank were also abortive, producing nothing other than boulder-clay. The delineation of the western boundary of the Ordovician is accordingly most inexact and the very fact that no feature is attributable to the Whittery Volcanic Group, which invariably is expressed in the topography, almost certainly shows the Ordovician is covered by glacial deposits almost as far as the Church Stoke – Chirbury road.

Classification of the Shelve Ordovician rocks

Lithostratigraphic subdivisions

The stratal subdivisions upon which Professor Whittard's map is based are lithostratigraphic units and represent the culmination of researches which began with Lapworth in 1887. The original terms were subsequently modified and expanded, particularly by Lapworth & Watts (1894, 1910), Lapworth (1916), Watts (1925) and finally Whittard (1931, and, to a lesser degree, 1940, 1955 and 1966). The manner in which the terminology evolved is shown by the comparative stratigraphical columns in Fig. 3. The stratigraphic terminology employed by Whittard and his predecessors does not conform with present-day requirements and does not follow the recommendations of either the Stratigraphic Committee of the Geological Society of London or the American Commission on Stratigraphic Nomenclature; consequently some appropriate modifications are proposed in the present paper. In an earlier publication, which contains his most detailed account of the Shelve Ordovician rocks (excluding the Habberley (now Shineton) Shales, of Tremadoc age), Whittard (1931) utilized a sequence of seventeen subdivisions, e.g. Mytton Flags, Aldress Shales, etc., which clearly correspond to what would nowadays be termed lithostratigraphic or rock-stratigraphic terms. Following Watts (1925 : 340) these were grouped into ten so-called 'Stages', an inappropriate method which utilized what is strictly a chronostratigraphic term for what were in fact groupings of lithostratigraphic subdivisions. These 'Stages' were then variously assigned to the 'Arenigian, Llanvirnian, Llandeilian and Caradocian', terms which in this form cannot be employed as Series of the Ordovician System. These last were replaced in the descriptive text of the same paper by the more appropriate usage of Arenig, Llanvirn, Llandeilo and Caradoc Series, though without comment. The same 'Beds' and 'Stages' were utilized in the 1948 (second) edition of the Geological Survey's handbook on the geology of the Welsh Borderland (Pocock & Whitehead 1948 : 42) but abandoned in the latest (third) edition of the same work by Earp & Hains (1971 : 41). Eventually Whittard (1952 : 156–165, table III) omitted all mention of the above 'Stages', while most of the lithostratigraphic terms of the 1931 paper were used and correlated with the various Series of the Ordovician, though the Hope Shales were shown as undivided.

In the first part of his Shelve trilobite monograph (Whittard 1955 : 5) the Tankerville Flags, previously regarded as the topmost of four subdivisions of the Mytton Flags that had fallen into disuse, re-entered the stratigraphical succession without comment as a separate subdivision between the Mytton Flags and the Hope Shales. The Tankerville Flags were clearly regarded by Whittard as meriting separate status as their trilobite fauna was listed by him later (1966 : 299) in the distribution tables for the monograph, but in the same work (1966 : 303) he pointed out that they could be distinguished in only a restricted part of the outcrop. The Tankerville Flags had obviously not proved a satisfactorily mappable unit and were not differentiated as such by Whittard on any of his 6 in to 1 mile field maps, where only the Mytton Flags occupy the position between Stiperstones Quartzite and Hope Shales.

For present purposes it has been deemed appropriate to divide the Shelve Ordovician (excluding Tremadoc) rocks into three Formations, names introduced by Lapworth, and subdivided in turn into members that correspond to the lithostratigraphic terms used by Whittard and earlier workers. As far as possible the type locality or stratotype for each member is listed and illustrated by extracts from Whittard's unpublished maps; additional data have been compiled from his manuscript notes and, where necessary, published papers. Among the unpublished notes was a proposed zonal sequence founded upon trilobites, the vertical distribution of which was shown in detail in Part 8 of the monograph (Whittard 1966 : 299–302), and this has been incorporated in

CARADOC DISTRICT	SHELVE INLIER		CHARACTERISTIC TRILOBITE	STAGE	SERIES	GRAPTOLITE ZONE
			ASHGILL SERIES NOT REPRESENTED IN SHROPSHIRE			Pleurograptus linearis Zone questionably present in Shropshire
Onny Shales or Onnia Beds	ABSENT		Onnia superba	ONNIAN	CARADOC	Dicranograptus clingani
			Onnia gracilis			
			Onnia? cobboldi			
Acton Scott Beds			Platylichas laxatus & Calyptaulax actonensis	ACTONIAN		
Cheney Longville Flags			Broeggerolithus transiens	MARSHBROOKIAN		Zones ill-defined
Alternata Limestone			Broeggerolithus longiceps	LONGVILLIAN		
Horderley Sandstone			Broeggerolithus globiceps & B. nicholsoni			
			Broeggerolithus soudleyensis	SOUDLEYAN		Diplograptus multidens
Glenburrell Beds	CHIRBURY FORMATION	Whittery Shale Mbr	Broeggerolithus broeggeri			
		Whittery Volcanic Mbr				
		Hagley Shale Mbr				
		Hagley Volcanic Mbr				
		Aldress Member	Broeggerolithus ulrichi	HARNAGIAN		
Smeathen Wood Beds & Harnage Shales			Salterolithus caractaci			
			Reuscholithus reuschi			
Coston Beds & Hoar Edge Grits		Spy Wood Member	Costonia ultima	COSTONIAN		
ABSENT	MIDDLETON FORMATION	Rorrington Member	Marrolithoides arcuatus & Spirantyx calvarina		LLANDEILO	Nemagraptus gracilis
		Meadowtown Member	Lloydolithus lloydi & Cryptolithus inopinatus			Glyptograptus teretiusculus
		Betton Member	Trinucleus acutofinalis & Bettonia		LLANVIRN	Didymograptus murchisoni
		Weston Member	Platycoryphe vulcani			
	SHELVE FORMATION	Stapeley Shale Mbr	Stapeleyella inconstans & Ampyx linleyensis			Didymograptus bifidus
		Stapeley Volcanic Mbr				
		Hope Member				
		Mytton Member	Bergamia rhodesi		ARENIG	Didymograptus hirundo
			ill-defined interval			Didymograptus extensus
			Myttonia confusa			
		Stiperstones Member	Neseuretus grandior			
			No fossils found			
Shineton Shales	Shineton Shales				TREMADOC	

Fig. 4 Table showing lithostratigraphic subdivisions for the Ordovician rocks of the Shelve Inlier and the Caradoc District of Salop, with the corresponding Series and Stages (where available). Since this paper was submitted, the name *Cryptolithus inopinatus* has been changed to *Whittardaspis inopinata*.

the correlation scheme for the Inlier shown in Fig. 4. The lithostratigraphic sequence given below is followed in the descriptive account of the Shelve Ordovician rocks.

Chirbury Formation	Whittery Shale Member	1000 ft+	(305 m+)
	Whittery Volcanic Member	300 ft	(91.5 m)
	Hagley Shale Member	*c.* 1000 ft	(305 m)
	Hagley Volcanic Member	350 ft	(107 m)
	Aldress Member	*c.* 1000 ft	(305 m)
	Spy Wood Member	300 ft	(91·5 m)
Middleton Formation	Rorrington Member	1000 ft	(305 ft)
	Meadowtown Member	*c.* 1300 ft	(396 m)
	Betton Member	600 ft	(183 m)
	Weston Member	3600 ft (Weston Member, Stapeley Shale Member and Stapeley Volcanic Member together)	(1100 m)
Shelve Formation	Stapeley Shale Member		
	Stapeley Volcanic Member		
	Hope Member	800 ft	(244 m)
	Mytton Member	*c.* 3000 ft	(914 m)
	Stiperstones Member	estd 400 ft	(122 m)

The Shineton Shales

These strata, cropping out along the Habberley Valley between the Stiperstones on the west and Pontesford Hill and The Longmynd on the east, were termed Shineton Shales by Callaway (1878 : 333) on the basis of their lithology and stratigraphical position. Later Lapworth (1916 : 37) introduced the term Habberley Shales for them, a name retained by Watts (1925 : 339) as there was then no faunal evidence available to prove their equivalence to the Shineton Shales. Palaeontological proof was subsequently provided by Stubblefield & Bulman (1927 : 116–118), whose faunal lists indicated a close correspondence with the strata of the Wrekin District. Whittard (1931 : 323, *et seqq.*) continued to use the term Habberley Shales in an account (1931 : 324, fig. 43) of an excavation, made in the vicinity of Granham's Moor Farm, near Habberley, which demonstrated what he described as an unconformity, marked by a 3 in (76 mm) band of conglomerate, at the base of the overlying Stiperstones Quartzite. In view of the correspondence of dip below and above the basal conglomerate of the Quartzite, the latter may perhaps be better regarded as disconformable rather than unconformable upon the Shineton Shales. A brief mention of this locality prior to excavation and a few notes of other localities constitute the only records of the Shineton Shales in the Whittard documents. A later account by Whitehead (*in* Pocock *et al.* 1938 : 72) thought it unnecessary to retain the name Habberley Shales and commented on Whittard's excavation to the effect that the Stiperstones Quartzite/Shineton Shales junction was conformable though 'not necessarily without a break in deposition'. In the first part of his monograph on the Shelve Ordovician trilobites Whittard (1955 : 5) continued to use the term Habberley Shales, but his last published note on the subject (1960 : 144) regarded them as synonymous with the Shineton Shales. Whether one should assign these Tremadoc strata to the Cambrian or the Ordovician is beyond the scope of the present work, in which the Shineton Shales are excluded from the Shelve Formation.

Lithostratigraphic description of the Shelve Ordovician rocks

Shelve Formation

First usage. As Shelve Series, by Lapworth (1887 : 662), composed of the Stiper Group, Ladywell Group and Stapeley Volcanic Group, in ascending order. The succession was later modified by Lapworth (1916 : 37) to comprise Mytton Group, Hope Group and Stapeley Group, though the lower and upper limits of the Shelve Series remained unchanged.

Type locality. Presumably the vicinity of Shelve hamlet, but no type section was designated.

Fig. 5 Eastern margin of Shelve Inlier, showing Pontesford Hill (Western Uriconian) at left, and hills formed by Longmyndian rocks. View looking NE from above Upper Yessons, 0·9 mile (1·5 km) east of Snailbeach and situated on the outcrop of the Shineton or Habberley Shales.

Stiperstones Member

First usage. As Stiper Group, by Lapworth (1887 : 662), overlain by Ladywell Group. The original usage stated that the Group included 'the well-known Stiper Quartzites' and the term 'Stiper Stones (Quartzite)' was later listed by Lapworth & Watts (1894 : 317). Since then the name Stiperstones Quartzite has come into general use and is replaced by Stiperstones Member, though employed in the same sense.

Type locality. The escarpment of the Stiperstones, but no specific type section was designated.

Descriptive notes. Quartzites of the Stiperstones Member form a structurally complicated outcrop extending NE from the vicinity of the River Camlad, 1·5 km (0·94 mile) SE of Disgwylfa (Squilver) Hill in the south, over the Heath Mynd to Black Rhadley where it is crossed by an important oblique fault, beyond which minor faulting imposes a zig-zag outline upon the western boundary as far as The Bog. Here the outcrop is reintroduced on the northern side of another major oblique fault and runs through broken ground, each faulted mass tending to produce a crag, so typical of the Stiperstones and culminating in the Devil's Chair (Fig. 7). Succeeding to the NNE are Scattered Rock and Shepherd's Rock, beyond which the outcrop, though still faulted, is not so intensely shattered and jointed. The strata can now be followed northwards fairly readily, there being a significant change in strike north and south of Blakemoorgate, but near Granham's Moor an oblique fault, approaching the quartzite outcrop from the west, curves into the strike and by repetition of the beds creates an increased breadth of outcrop as far as just beyond Nill's Hill. North of here the breadth is once more reduced, the strike swings NE, and the outcrop terminates against the Coal Measures and glacial deposits of the Pontesbury district after having covered a distance of more than 10 miles (16 km).

The Stiperstones Member is composed of hard, resistant rocks and forms an eastern edge to the Shelve Inlier which attains a maximum height slightly in excess of 1725 ft (526 m). All along the escarpment the quartzite tends to weather into crags but nowhere is this type of topography

Fig. 6. Outcrops of Stiperstones (Quartzite) Member. View looking north from point south of Manstone Rock, between Devil's Chair and Cranberry Rock.

so well seen as between Cranberry Rock and the Paddocks, and The Rock and Nipstone Rock, which significantly are the two lengths where the outcrop shows the most complex fault-pattern.

Reliable figures for the thickness of the Stiperstones Member are difficult to determine. The angles of dip vary quickly and range from 40° to vertical, whilst in some places, as on both sides of the River West Onny and at Nill's Hill, the dip is reversed to the east. Nowhere is there a section through the Member, neither the upper nor the lower limit is visible in more than a few places, and only indirect evidence of the thickness can be utilized. Topography is a most uncertain guide because the escarpment is continually being degraded, crags are actively being reduced in height and enveloped in scree-clitter and, by virtue of bedding and of jointing parallel to the strike, rocks fall on both dip and scarp slopes. The marked change of slope on the scarp side suggests the outcrop of the softer Shineton (=Habberley) Shales, Tremadoc Series, but this can be deceptive because at several locations undoubted exposures of quartzite occur in what, on this assumption, should have been Tremadoc ground. Consequently the Stiperstones Member may at times be below the surface but farther down the scarp than is expected, and its failure to crop out is due to 'scaling-off' of the quartzites along the joints. On the dip slope, exposures are hardly ever seen owing to the blanket of quartzite blocks, heather and whinberry. How far west the top of the Member extends is frequently difficult to determine, and topography reveals little because the quartzites show a zone of gradation into the slightly less resistant Mytton Member. Thus the thickness of the Stiperstones Member as shown in the craggy exposures appears to be not more than 100 ft (30·5 m), which generally is probably correct because the crags are eroded from faulted blocks in which the top or bottom, or sometimes both boundaries, of the subdivision are cut out. The thickness of the Stiperstones Member probably does not exceed 550 ft (167·6 m) in the north of the inlier between The Paddock and Lord's Hill, but apparently increases SW to *c.* 650 ft (198 m) on the south side of Heath Mynd. The beds are probably strongly diachronic but palaeontological evidence is insufficient to prove this. The Member is invisible at the surface in the Shelve Anticline, but the estimated depth at which it has been supposed to occur is 1200 ft (366 m) (Hall 1919 : 12; Dines 1958 : fig. 2).

The dominant rocks of the subdivision are massive, compact and usually moderately well

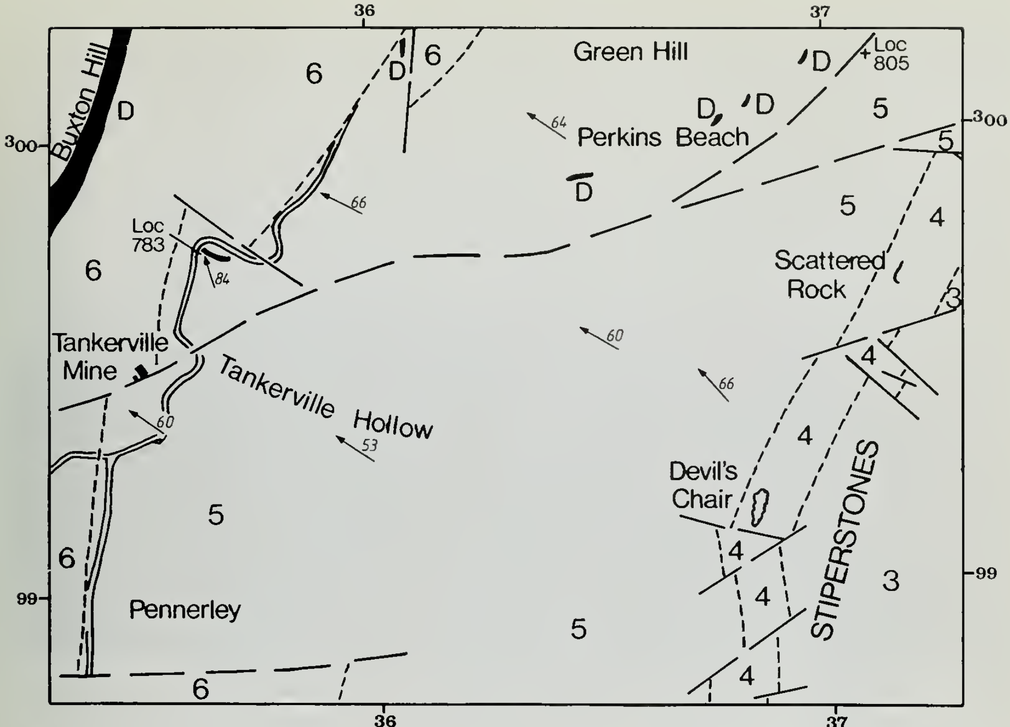

Fig. 7 Geological map of the area between Myttonsbeach and The Bog. Adjoins Fig. 10. 3 = Shineton Shales; 4 = Stiperstones Member; 5 = Mytton Member; 6 = Hope Member; black outcrop D = dolerite. (SO 39 and SJ 30)

bedded quartzites which are white, light grey, bluish-white or liver-coloured; they are sometimes colour-banded in alternations of bluish-grey and light fawn. The banding accentuates false bedding as seen on weathered joint faces, for example at the northern end of the Manstone Rock; occasionally the bedding is lenticular and produces lenses up to 2 ft (60 cm) long and a few cm thick; at other times it is undulose, the wavelength being 2–3 ft (about 75 cm) and the amplitude a few cm; symmetrical ripple-marks are uncommon, as in the Nill's Hill quarries. Hard, shiny, black bitumen was noted on joint faces north of The Hollies, Snailbeach and at Nill's Hill. Bedding surfaces show burial preservation examples of *Chondrites* sp., animal tracks referred to *Cruziana semiplicata* Salter (1866: 292) and fucoidal markings, but the commonest remains are worm-tubes infilled with sand which is coarser-grained than that of the surrounding quartzite. The tubes are at right angles to the bedding, frequently show paired openings as though they are U-shaped, and vary in diameter from $\frac{1}{8}$ to 1 in (3–25 mm). In regions where dips are high and the quartzites severely jointed, as at the Devil's Chair, the occurrence of these infilled worm-tubes is a distinct aid to the determination of bedding. Angular fragments of blue-black shale and sandy mudstones, as much as 2 in (5 cm) across and indistinguishable from the Mytton Member, lie in the bedding planes; they have often been removed from the quartzite by weathering, leaving characteristically-marked surfaces with flat-bottomed, vertical-sided, irregularly rectilinear depressions. Much of the compact quartzite is secondarily silicified and in extreme cases is converted into chert-like rocks; rarely the quartzites are felspathic.

The most frequently seen conglomerates are pale in colour, occur at any horizon, and are normally composed of a quartzite matrix in which small pebbles of quartz, chalcedony, quartz aggregate and cryptocrystalline felsite, rarely spherulitic, are included, and they seldom exceed 1 in (2·5 cm) in maximum diameter. Noteworthy is the absence of granite types and of feldspar,

Fig. 8 View of the Stiperstones, with Tankerville Hollow on left, looking east from Round Hill, 0·7 mile (1·1 km) ENE of Shelve hamlet.

unless some of the fine-grained micaceous pebbles are highly weathered feldspar in which all traces of twinning are lost. The basal conglomerate, 3 in (7·5 cm) thick, exposed in an excavation by the side of a derelict concrete tank opposite Granham's Moor quarries, is much darker in colour owing to ferruginous and chloritic fragments, and interstitial argillaceous matter. The provenance of the conglomerates, and also of the quartzites, is unknown. If the derivation had been from the east, i.e. the direction of the immediate land-region of those times, the content of Uriconian and Longmyndian material would have been much higher than it is; consequently, an along-shore drift of sediment, presumably from the SW, is not unlikely. Also possibly bearing on this problem is the existence at Pontesford, only 1–2 miles (about 2·5 km) away, of representatives of the Caradoc Series which rest directly upon Pre-Cambrian. There are many geological anomalies here; the unconformity at Pontesford is undeniable yet there is no evidence of such an important hiatus in the corresponding succession of the Shelve Inlier. Important faults occur between the Inlier and the Ordovician outcrop of Pontesford, and two geological regions which were at one time widely separated may have been abruptly collocated by strike-slip faulting in which the movement was essentially horizontal, while downthrow may have brought to about the same present topographical level two deposition surfaces which originally were separated, relative to one another, by a large vertical interval.

The entire thickness of the Stiperstones Member is not, however, made up of quartzite and conglomerate. Towards the base are interbedded silvery, greenish-white, soft, soapy shales which have yielded dendroid graptolites and are only a few cm thick, whilst at Nills Hill thin papery shales and sandstones are present in bands up to 10 in (25 cm) thick. Elsewhere thin, micaceous, dark grey shales alternate with layers of coarse but friable quartzite, and these are included within massive quartzites. In the mid-thickness of the subdivision both soapy shales and fucoidal flags similar in lithology to the Mytton Member occur.

As revealed under the microscope, much of the compact quartzite has been secondarily silicified. Within narrow limits the grains are generally of uniform size and form an interlocking mosaic: the clear secondary silica has grown in optical continuity with the quartz of the original grains, which are frequently dusty from inclusions and are rounded, the ghost of their outlines being clearly evident in many samples. At other times, the original outline is lost and secondary silicification is then recognized by the irregular sutural contacts made between individual quartzite components. Secondary growth of silica does not usually form around quartz aggregates.

The normal sedimentary base of the Stiperstones Member has not been seen in any natural exposure, but the contact with the Shineton Shales was found to be exceedingly sharp in an excavation made some years ago near a disused concrete tank on the opposite side of the valley to the lower Granham's Moor Quarry. At its eastern extremity the excavation showed olive-green shales and micaceous flags; 5 ft (1·5 m) below the succeeding conglomerate Dr C. J. Stubblefield in 1931 collected *Shumardia pusilla* (Sars) and *Lingulella nicholsoni* Callaway, thus proving their Tremadoc age, *Shumardia pusilla* Zone (Whittard 1931 : 344). Resting upon, and inclined at the same angle as, these Shineton Shales is a 3 in (7·5 cm) band of dark, distinctive conglomerate which makes a clean-cut junction and is of a type unknown from the main mass of the Stiperstones Member. The conglomerate is succeeded by a thin band of broken shale, unlike the Shineton Shales, and finally by flaggy quartzites which definitely belong to the Stiperstones Member. The excavation was terminated by blocks of quartzite set in a sandy matrix, but these were not *in situ*. The junction between the Stiperstones Member and the Shineton Shales was taken at the base of the conglomerate because (i) no conglomerate is known in the Shropshire Tremadoc rocks; (ii) the conglomerate consists mainly of angular quartz grains, interstitial ferruginous and chloritic material, and rounded pebbles of quartz and quartz-aggregate, all of which can be matched in undoubted Stiperstone quartzite; and (iii) the Stiperstones Member is disconformable to the Shineton Shales as the younger of these Tremadoc deposits belong to the *Shumardia pusilla* Zone, whilst representatives of the higher *Apatokephalus serratus* Zone are absent. The disconformity can only be inferred on palaeontological and lithological evidence, because there is no discordance in angle of dip, neither is there any detectable difference in strike; but with such easily-deformed strata as make up the Shineton Shales, the mass of the overlying, thick Arenig beds has probably brought the inclination of their upper layers into coincidence with that of the quartzites.

The upper limit of the Stiperstones Member is different from the lower because there is no sharp line of demarcation; indeed, the condition is that found in passage beds where one lithology is superseded by another through a thickness of alternating types. Stratigraphically above the dominantly quartzitic beds is an interval, of unknown magnitude, wherein the light-coloured, secondarily silicified, clean quartzites alternate with striped, micaceous, rusty-weathering, bluish-grey shales and siltstones of an aspect like rocks found in the Mytton Member; these are included in the Stiperstones Member. Still higher, however, the clean quartzites are replaced by dirty, dark quartzites, usually but not always thin-bedded, carrying much argillaceous matter, alternating with sandy shales and flags; these are placed in the Mytton Member and clearly represent a sedimentary transition. Whereas the lower limit of the Stiperstones Member is precise, the upper can be drawn on the map only arbitrarily.

The commonest indications of organic life in the quartzite are innumerable worm-tubes of many sizes, 1 in (2·5 cm) and less in diameter, frequently but not always U-shaped, and filled with coarser-grained material than the enclosing sediment. Salter (1866 : 243, 256, 291–293, fig. 2; pl. 11B, fig. 27) compared the burrows with *Arenicolites linearis* (Hall). No corrugated skin has been detected in the many tubes which have been examined in the quartzites. The only other fossils are two pygidia of a large trilobite, *Neseuretus grandior* Whittard, and a sponge-spicule of which four axons are identifiable in thin-section. Until recently these were all the known fossils from the Stiperstones Member but now a few dendroid graptolites and some anomalous and structureless remains, which may be algal, have been recovered from silvery and soapy shales interbedded with quartzite in the quarry at the NW corner of Poles Coppice, north of Granham's Moor Farm. Unfortunately *Neseuretus grandior* and the dendroids are valueless for detailed correlation. *Neseuretus* is found in the Lower Ordovician, is particularly common in parts of the Mytton Member, and there is no reason to consider the Stiperstones Member to be other than Arenig in age.

Fig. 9 Mytton Batch (=Myttonsbeach) and Snailsbeach, formed by rocks of the Mytton Member. View looking NNE from above Bergam, 1·3 miles (2·1 km) NNE of Shelve.

The quartzites accumulated as coarse-grained, worm-ridden sands with pebbly layers, and comprise a well-sorted deposit generally washed clean of mud. The fact that animal tracks were impressed and preserved suggests that the water was shallow and, indeed, the conditions may have been littoral. The sands were covered by muds for short intervals, particularly during the earlier periods of deposition, but mud and sandy mud became dominant towards the top of the subdivision as Mytton Member conditions became established.

Mytton Member

TYPE LOCALITY. Mytton Batch, near Snailbeach (Whittard 1960 : 194).

FIRST USAGE. As Mytton Group, by Lapworth & Watts (1894 : 316), later renamed Mytton Flags by Lapworth & Watts (1910 : 752). The term Mytton Group as employed later by Lapworth (1916 : 37) was equivalent to the Stiper Quartzite and Mytton Flags of previous accounts; it was subsequently renamed Mytton Stage by Watts (1925 : 341), a term employed temporarily by Whittard (1931 : 323), and is now no longer used. Whittard's (1931 : 323, 325) usage of Mytton Flags corresponds to the present Mytton Member. He noted also Lapworth's subdivision of the unit into the following:

4. Tankerville Flags
3. Shelve Church Beds
2. Ladywell & Snailbeach Grits and Flags
1. Lord's Hill Beds.

The lowest of these was said to be unfossiliferous but brief notes were given on the faunas of the other three. Later Whittard (1940 : 154; 1952 : 157, table on p. 165; 1953 : 239, 240) used Mytton Flags in a similar sense without further subdivision and, noting Lapworth's thickness of 1600 ft (490 m) as being far too small, gave a figure of *c*. 3000 ft (915 m). He appears to have been uncertain how to treat the problem of further subdivision because in the first part of his trilobite monograph (1955 : 5) he reverted to the fourfold subdivision of Mytton Flags. In Part 8 of the same monograph, his final published contribution to the subject (1966 : 299–304), he rejected the term Shelve Church Beds (and presumably also the Lord's Hill, Ladywell and Snailbeach Beds) but retained the Tankerville Flags as a subdivision between the Mytton Flags and the Hope

Shales, though acknowledging that the distinctive lithology (comprising *c.* 100 ft (30·5 m) of 'bluish-grey flaggy shales with but little content of arenaceous material') and fauna could be recognized 'only over a restricted part of the outcrop'. The field mapping completed by Whittard shows only undivided Mytton Flags (now Mytton Member of the Shelve Formation), and nowhere was a separate Tankerville unit mapped. Consequently it is preferred to disregard the latter for most practical purposes although, in view of Whittard's 1966 remarks, the topic is discussed further with reference to the Tankerville area.

Descriptive notes. Whittard (1931 : 325; 1960 : 194) noted the rocks only briefly as rusty-weathering, olive-green, ribbed, flaggy, sometimes quartzitic siltstones and bluish-grey, flaggy shales with a total thickness of *c.* 3000 ft (915 m). Lapworth & Watts' map (*in* Pocock & Whitehead 1948 : pl. 11) showed 'Mytton Flags & Shales' occupying two large outcrops within the Shelve Inlier: an elongated area NW of the Stiperstones and forming part of the eastern limb of the Ritton Castle Syncline and a subelliptical area centred approximately on the Shelve District and forming the core of the Shelve Anticline. This distribution corresponds broadly to the one shown in the present work.

In general the rocks of the Mytton Member comprise rusty-weathering, massive and flaggy, grey-green and blue-black siltstones and subsidiary shales. Although less resistant to erosion than the quartzites of the Stiperstones Member, the beds are generally more resistant than the shales of the succeeding Hope Member and form the conspicuous area of high ground extending from mid-way between Pontesbury and Minsterley SSW to Pennerley, beyond which the outcrop narrows markedly at the marshy area of The Bog. As Whittard (1931 : 325) emphasized, the rocks of the Mytton Member are important in that they contain the majority of the principal mineral veins (galena, blende, barytes) of the district and the remains of old workings are commonplace over much of the outcrop. Mining in the Shelve Inlier has since been reviewed in some detail by Dines (1958), who demonstrated that fault fissures receptive to mineral deposition are better developed in 'harder' formations such as the flags of the Mytton Member and die out in shales, where the veins are barren. The quartzites of the Stiperstones Member, although a hard formation, contain virtually no mineral deposits but the latter are common in rocks of the Mytton Member owing to the sealing effect of the overlying shales of the Hope Member, which prevented the upwards migration of mineral-bearing solutions. In the relatively few cases where mineralizing solutions escaped through the Hope Member shales to higher stratigraphic horizons in the Stapeley Volcanic and Hagley Volcanic Members, the occurrences are of barytes with only a few traces of galena and blende.

The striking unwooded valleys which drain the west side of the high ground underlain by the Stiperstones and Mytton Members are known locally as 'batches' or 'beaches'. They are remarkable physiographic features and in the case of Mytton Batch, usually written as Myttonsbeach on present-day maps, the slope of the head of the valley, covered by heather and whinberry, is 35°. Whittard's notes speculate that although it has been suggested that some of the batches are due to marginal overflows formed during the glacial period, they may in fact have originated from springs of which the flow passed down into the much lower-lying country occupied by the regressive Hope Member. If the difference in level was maintained between country formed of Mytton Member and that made of Hope Member, the velocity of the stream would be high and would give it considerable power to cut back quickly. The batches do not show devious courses – they are almost straight.

Mytton Batch, type locality for the Mytton Member, is a valley (Fig. 10) running east–west on the north side of Green Hill, some 3 miles (4·8 km) SSW of Minsterley. The rocks are particularly well exposed along the north side of the batch forming the south flank of Oak Hill. Those exposed in the section between the Minsterley – Pennerley road, near the one-time Stiperstones Inn, and the area east of Myttonsbeach cover the greater part of the succession, but the lowest strata are not visible and the first exposures recorded there are at MS Locs 832, where massive, brecciated siltstone, veined with quartz, is seen, and 831, where the rocks dip 46° at 315° true. The latter locality shows massive siltstones which in no way resemble shales, and this type of lithology is found elsewhere, including the heads of the batches, e.g. Tankerville Hollow (see p. 13). Generally

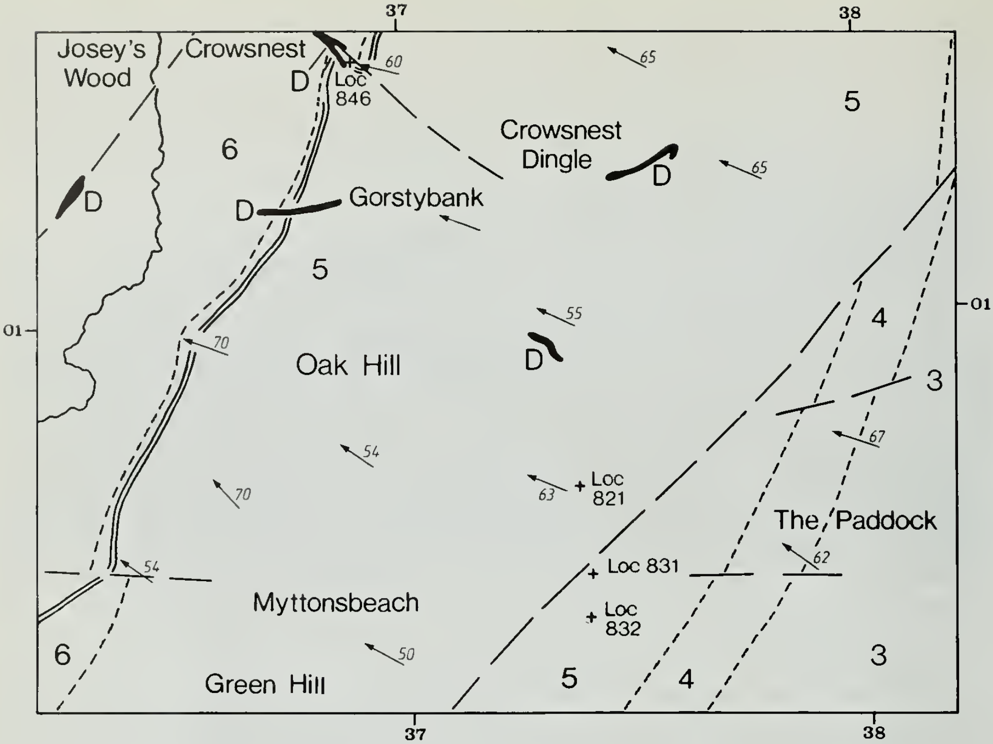

Fig. 10 Geological map of the Mytton Member at and north of the type locality. Adjoins Figs 7, 11. 3=Shineton Shales; 4=Stiperstones Member; 5=Mytton Member; 6=Hope Member; black outcrop D=dolerite. (SJ 30)

speaking, the softer siltstones and shales, particularly at the top and near the base of the Mytton Member, have proved fossiliferous, but the middle part of the succession, constituting the greatest thickness, comprises coarse siltstones, some of them very massive, and fossils are rarely found therein. From here westwards, there are numerous exposures in the area just east of the head of Myttonsbeach, including fossiliferous flags (Loc. 821) with *Myttonia confusa* Whittard, *Neseuretus* and *Ogygiocaris selwynii* (Salter), but these end at the valley, though the section continues along the top of its northern slope. Very massive flags make the main edge-feature of Mytton Batch, coarse siltstones of a type encountered in many places throughout much of the thickness of the Mytton Member. Looking downhill along the strike of these rocks, one can see three distinct ridges separated by hollows, features which indicate the alternation of hard and softer rocks. A similar alternation is applicable to most of the thickness of the Member as seen elsewhere in the district. Not only is there a coarse alternation involving thicknesses of up to 100–200 ft (30·5–61 m), but also within these thicknesses there are minor hard and soft strata alternating and in this respect the rocks of the Mytton Member are not unlike those of the Weston Member (see p. 38). This, however, is not the condition of the lowest beds, which are usually softer, silvery-grey weathering and frequently fossiliferous. The latter are the so-called 'Lord's Hill Beds' of Lapworth, and if we exclude these and the softer strata of the 'Tankerville Flags' from the total thickness, we are left with by far the greatest proportion of the Mytton Member made up of more massive rocks which presumably are Lapworth's 'Ladywell and Snailbeach Grits'.

On the south side of Green Hill the valley called Perkins Beach (Fig. 7, p. 13) contains numerous exposures of the Mytton Member, though the section is less extensive than that of Myttonsbeach. Loc. 805, beside an old adit, is important as it has yielded what is apparently the oldest fauna known from the Member, comprising *M. confusa*, *O. selwynii* and *Neseuretus* preserved in silver-grey weathering, micaceous, silty shales and flags. An interesting feature of this area is the occurrence of doleritic intrusions, which appear at the surface in crags and then disappear uphill; when followed along their strike, their place is taken by Mytton rocks which are sometimes indurated, sometimes not. One has the impression that the dolerites have only been exposed by the excavation of the valley, without which it is doubtful whether they would have broken surface.

The manner in which the main thickness of the Mytton Member is made up largely of greyish-weathering, blue-hearted siltstones is evident when working along Perkins Beach and the valley known as Tankerville Hollow, which runs ESE from Tankerville Mine (Fig. 7). The name Tankerville, incidentally, derives from an old term for an oven-pipe or organ-pipe, and refers to the shape of some of the mine shafts, which were narrower at the base than at the top. The alternation of predominant siltstones, which are usually exposed but yield few fossils, with shales, which may be fossiliferous but are rarely exposed, has made it impossible to subdivide the strata of the Mytton Member on the basis of their faunal content.

Bergam Quarry (Loc. 783), sited *c.* 1000 ft (305 m) NNE of Tankerville Mine and excavated in the highest portion of the Mytton Member (Fig. 7), is of interest as being the first locality at which species common to this horizon and the succeeding Hope Member were discovered. The rocks are bluish-grey, micaceous, flaggy shales with but little content of arenaceous material, and are hardened by a dolerite intrusion some 14 ft (4·3 m) wide. The shales on the north side of the intrusion are pale grey through a width of 11 ft (3·4 m), but those on the south side are not visibly altered. Fossils are hard to come by nowadays, but in the past the locality has yielded *Didymograptus hirundo* and numerous trilobites including *Bergamia rhodesi* Whittard, *Ectillaenus*, *Geragnostus*, *Placoparia* and *Pricyclopyge*.

To the south of Tankerville Hollow exposures of Mytton Member become fewer and an east–west fault running through Pennerley Mine (see Fig. 7) offsets the outcrop eastwards adjacent to the swampy area of The Bog. In the vicinity of The Bog lead mine no rocks are now visible *in situ*, though the tip heaps are composed of Mytton Member débris, but *c.* 1000 ft (305 m) to the ENE Loc. 279 yielded a single example of *Ogygiocaris* and a dubious *Tetragraptus*.

The outcrop of the Mytton Member narrows markedly to the south of The Bog and, accompanied by an elongated series of small faulted 'blocks' of Stiperstones Member, runs in a narrow strip bounded by two convergent faults which meet just south of the River West Onny and east of Cefn Gunthly (Map). From there to its termination about half a mile (0·8 km) east of Snead the outcrop is not well exposed and the western boundary is faulted against rocks of the Hope Member. The rocks are seen only intermittently on the heath-covered ground in the vicinity of Heath Mynd, and make up the eastern part of the hill feature of Roveries Wood, to the south of which they are overlain unconformably by Lower Silurian beds.

Turning to the area north of Myttonsbeach, the valley of Crowsnest Dingle shows numerous exposures of the more massive siltstone beds but, again, these die out eastwards so that the lowest strata of the Member are not exposed. Half a mile (0·8 km) farther NE the area east of Snailbeach (Fig. 11) is more informative. Immediately west of the mapped base of the Mytton Member is a building called Eastridge, just west of which, at Loc. 858, are exposures of typical flags with a preponderance of much harder layers of quartzitic rock. It is evident that the beds represent a transition from those of the Stiperstones Member, and similar strata follow successively to the west where, at Loc. 860, apparently the youngest beds of this sequence are still quartzitic and include a band 7 ft (2·13 m) thick. Whittard clearly contemplated separating these unfossiliferous, transitional rocks under the name Eastridge Beds, but their outcrop was shown only sketchily in the vicinity of Eastridge and he appears not to have recognized them elsewhere. In the same valley, however, and only a short distance south along the strike from Loc. 860, is an exposure (Loc. 158) of buff-weathering, bluish-grey hearted 'grits' which Whittard, in his notes, considered to be probably the 'Snailbeach Grits' of Lapworth. This conclusion seems arguable as the rocks occur below the shaly strata of Lordshill (see p. 18), and Lapworth (1916: 37) placed his 'Ladywell and Snailbeach Grits and Shales' above his 'Lord's Hill Beds'. However, to use either of these possibly synonymous terms, which cannot be employed with confidence outside a relatively restricted area, is to risk nomenclatorial confusion and it would be better to allow both to lapse.

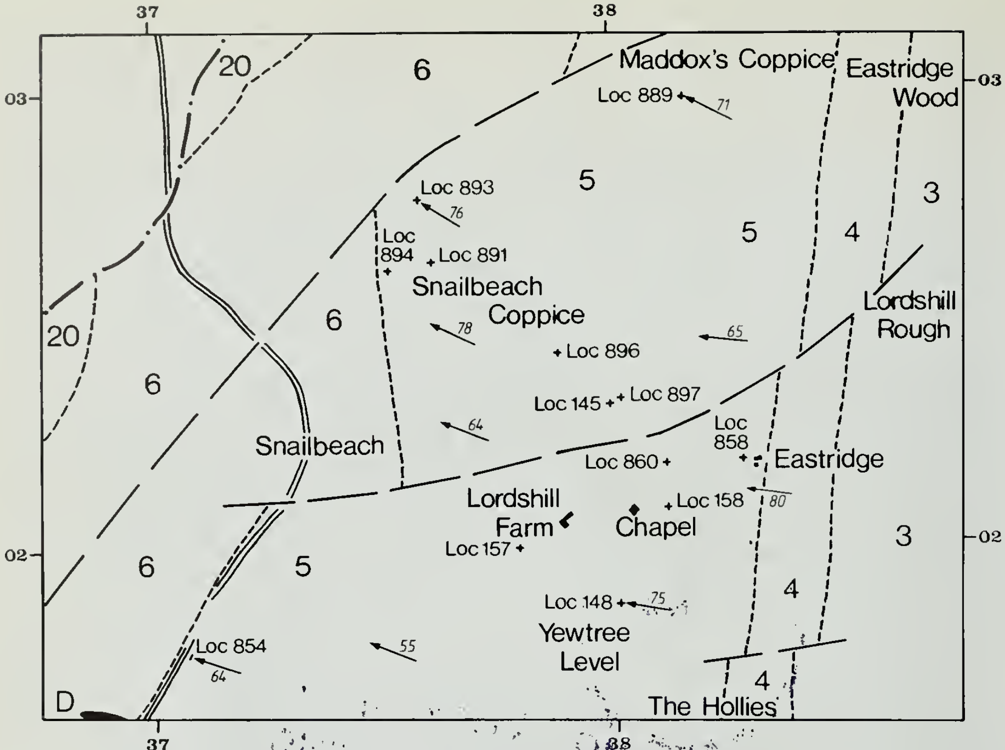

Fig. 11 Geological map of the area around Snailbeach. Adjoins Fig. 10. 3 = Shineton Shales; 4 = Stiperstones Member; 5 = Mytton Member; 6 = Hope Member; 20 = Silurian rocks; black outcrop D = dolerite. (SJ 30)

Although Whittard's notes state that the Lord's Hill Beds 'must not be confused with the fossiliferous beds of Lord's Hill so often mentioned by Salter', he appears to have used the terms in at least partly similar sense. South of the Baptist Chapel at Lordshill, towards Yew Tree Level, and to the north, in the vicinity of Perkins Level, shaly and occasionally flaggy beds overlie the transition beds noted above and have proved fossiliferous at a few places (Locs 145, 148, 897) along the strike; the fauna includes *Bergamia rhodesi*, *Myttonia confusa*, *Neseuretus parvifrons* (Salter), *Ogygiocaris selwynii* and *Redonia anglica* Salter.

Successively higher beds are encountered westwards along the road from Lordshill to Snailbeach and, to an even greater degree, NW from Perkins Level through Snailbeach Coppice. A dry, right-angled 'gutter' (Loc. 157), possibly a glacial overflow channel, centred *c.* 250 ft (76 m) west of Lordshill Farm, shows a large exposure in green-weathering, greyish, resistant, gritty flags. Across the valley and at a slightly higher horizon, a small pathside quarry (Loc. 896) *c.* 500 ft (150 m) NW of Perkins Level shows hard, blocky, jointed siltstones which are cut by a small dolerite intrusion immediately to the south. The beds here and in the adjacent spoil heap at one time yielded fossils including trinucleids, *Neseuretus* and *Ogygiocaris.* Other exposures (Fig. 11) in Snailbeach Coppice merit little detailed description but Loc. 891 shows massive quartzitic siltstones, while flags at Loc. 893 are disturbed by doleritic intrusions. The rocks at Loc. 894, a sunken cart-track, are apparently almost at the top of the Mytton Member but do not resemble the lithology of the 'Tankerville Flags' discussed earlier. A note here mentions that 'Tankerville Flags' were last seen in the roadside section (Loc. 846) just south of Crowsnest Dingle (Fig. 10, p. 18), but the field notes for that place mention only 'Mytton Flags'. The development of 'Tankerville Flags' in this area seems inadequately documented, though flags exposed by the side of the old railway at Loc. 854, *c.* 700 ft (210 m) NE of Crowsnest (Fig. 11), were described as

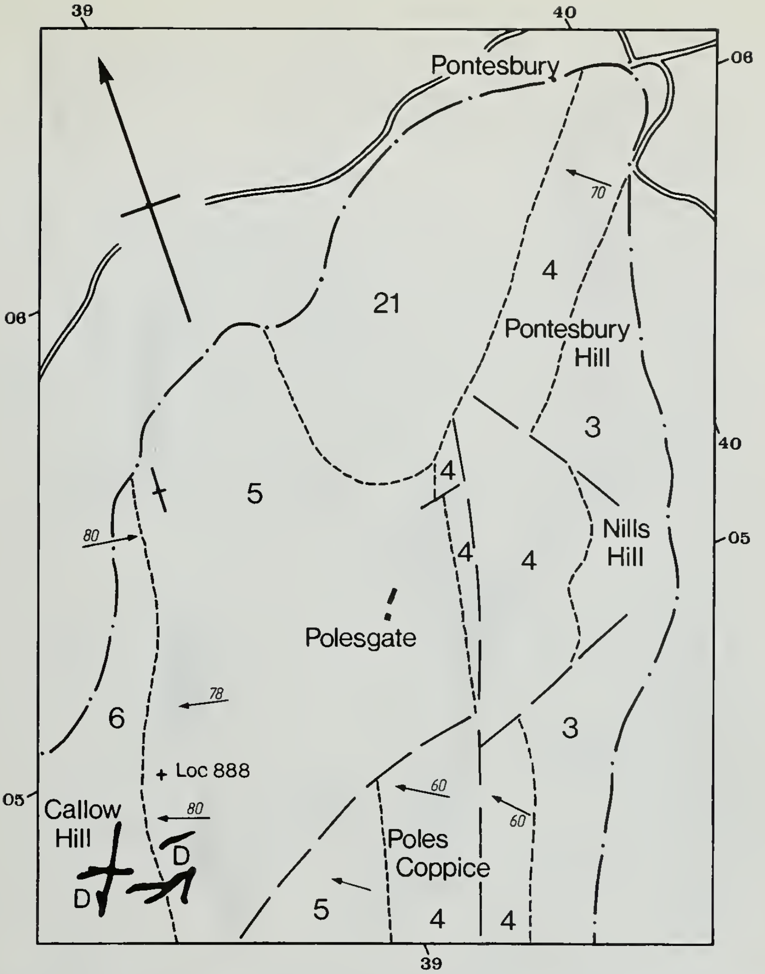

Fig. 12 Geological map of the area south of Pontesbury. 3=Shineton Shales; 4=Stiperstones Member; 5=Mytton Member; 6=Hope Member; 21=Carboniferous rocks; black outcrop D= dolerite. (SJ 30)

'slightly more shaly than usual'. The wooded area of Maddox's Coppice, immediately NE of Snailbeach Coppice, contains few exposures but an old adit (Loc. 889) yielded fossils in silty shales and mudstones which occur at approximately the same horizon as similar strata near Perkins Level.

The Mytton Member's outcrop extends NNE (Fig. 12) to within about half a mile (0·8 km) of Pontesbury, where it is overlain unconformably by Carboniferous strata. Adjacent to the faulted western boundary is a large quarry (Loc. 888), excavated in the NE part of Callow Hill and approximately three-quarters of a mile (1·2 km) east of Minsterley. The rocks there are cut by dolerite intrusions which extend into the adjacent outcrop of the Hope Member; they show little variation and consist for the most part of massive, rusty-weathering, blue-grey siltstones which sometimes show thin, argillaceous layers and rod-like fucoidal structures.

All the outcrops of the Mytton Member so far considered form part of the eastern limb of the Ritton Castle Syncline. The remainder constitute an inlier, *c.* $2\frac{1}{2}$ by $\frac{1}{2}$ to $\frac{3}{4}$ mile (4×*c.* 1 km) and elongated ENE, which forms the core of the Shelve Anticline. Truncated at its SW end by one of the Shelve Inlier's set of principal north–south tear-faults, the overall outcrop is divided into two

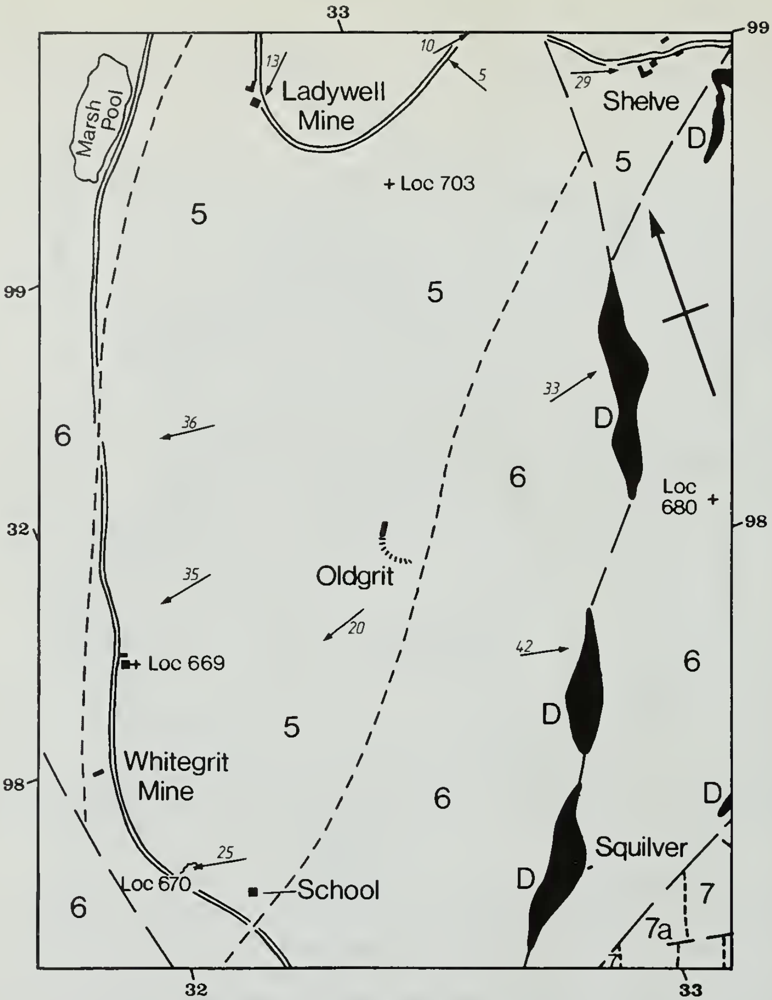

Fig. 13 Geological map of the area SW of Shelve hamlet. Overlaps Fig. 14. 5 = Mytton Member; 6 = Hope Member; 7 = Stapeley Volcanic Member (7a = interbedded shales); black outcrop D = dolerite. (SO 39)

subequal parts by a second, subparallel fault which runs through Roman Mine and just west of Shelve hamlet. The SW part is centred broadly on Shelve Hill (Fig. 13), an elongated feature which stands notably higher than the surrounding, often badly-drained ground underlain by regressively-weathering shales of the Hope Member. Scattered exposures are most common towards either end of Shelve Hill, where three disused mines (Whitegrit, Oldgrit and Ladywell) are situated, but good sections are generally lacking. An old quarry (Loc. 670) 450 ft (137 m) NW of Whitegrit school exposes sandy, micaceous flags, weathering yellowish-grey, from which the type material of *Dictyonema cobboldi* Bulman (1928 : 33), together with *D. irregulare* Hall, was obtained. The locality was quoted by Whittard (1931 : 327) as being 330 yd (300 m) SSW of Whitegrit Mine, a misprint for SSE. About 450 ft (137 m) east of the same school, a collapsed mine shaft and its associated tip heaps of blue-hearted, shaly flags were noted by Whittard (1953 : 240) as having proved fossiliferous. The fauna includes *Ogygiocaris selwynii*, *Monobolina plumbea* (Salter), *Redonia anglica*, hyolithids and rare *Didymograptus*. In this area the linear arrangement of shafts and tip heaps running ENE between Whitegrit and Oldgrit suggests a

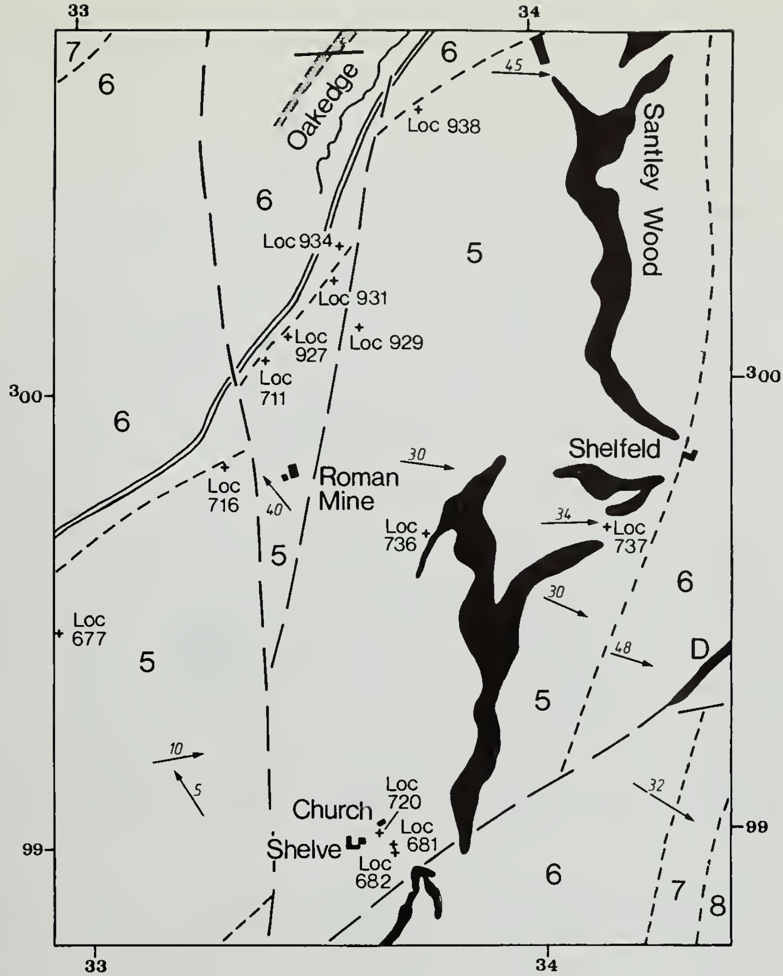

Fig. 14 Geological map of the area north of Shelve hamlet. Overlaps Figs 13, 15, 16. 5 = Mytton Member; 6 = Hope Member, including 'chinastone' tuff bed (dotted); 7 = Stapeley Volcanic Member; 8 = Stapeley Shale Member; black outcrop D = dolerite. (SO 39, SJ 30)

line of at least brecciation if not faulting. In the same general area Loc. 669, 800 ft (244 m) at 034° true from Whitegrit school, produced only two specimens of possible ogyginid trilobites and a fragmentary graptolite, but the rocks are of interest as being softer than the typical lithology and probably lie very close to the top of the Mytton Member. At the NE end of Shelve Hill the rocks are not well exposed, and spoil heaps of shale (Locs 677, 703) in the vicinity of Ladywell Mine (Figs 13–14) nowadays provide the best opportunity for collecting fossils. The latter include *Ampyx salteri* Hicks, *Neseuretus*, *Ogygiocaris selwynii* and *Didymograptus*.

At the northern extremity of the SW half of the Mytton Member outcrop, beds very close to the boundary with the Hope Member are reported from the neighbourhood of Loc. 716, just west of Roman Mine (Fig. 14). As the hill is descended there appears to be an increase in shales approaching the condition of those forming the Hope Member and in this area there is thus at least a suggestion of a gradational boundary, a situation contrasting with that described in notes on part of the Hope Valley where a gradation was not definitely observed (see p. 24).

East of the north–south tear fault already noted as passing through Roman Mine, the NE half of the Mytton outcrop is roughly rhombic in outline, its SE boundary faulted against the

Hope Member. At Shelve hamlet the best-known rocks are those known at one time as Shelve Church Beds; they were once clearly exposed (Fig. 14) in the road beside All Saints Church but that outcrop is now much overgrown or built over and the beds are visible only in an adjacent field (Loc. 720). Excavation there exposed blue-black, shaly flags interleaved with silver-grey weathering, rusty-coated, blue-hearted shales in which the mainly graptolitic fossils occur matted together in thin bands. The fauna, though much quoted (for example by Whittard, 1931 : 326), has not received modern descriptive treatment but is famous for dendroids such as *Dendrograptus*, *Dictyonema* and *Desmograptus*, while graptolites including *Didymograptus extensus* (Hall) and *Glyptograptus dentatus* (Brongniart) also occur. Shelly fossils are in a distinct minority. Whittard's rejection of the term 'Shelve Church Beds' was noted earlier. In the relatively small area between Shelve Church and the faulted boundary against Hope Member to the SE, typical though unfossiliferous rocks of the Mytton Member were recorded at Loc. 681 (Fig. 14) while nearby, at Loc. 682, the 'Shelve Church Beds' lithology was seen, only a few metres from shales of the Hope Member which have been hardened by a dolerite intrusion. No other exposures of note occur in the immediate vicinity of Shelve but to the NE the outcrop is invaded by a large dolerite intrusion and metamorphosed 'flags' were at one time quarried at Locs 736 and 737, respectively WSW and SW of Shelfeld Farm.

From here to the NE apex of their subrhombic outcrop, the rocks of the Mytton Member are intruded by three additional masses of dolerite, the largest of which is elongated roughly north–south and underlies the western half of Santley Wood (Fig. 14). In the area immediately west of these intrusions the boundary between the Mytton and Hope Members is not actually visible but must lie near the base of the physiographic feature formed by the Mytton rocks near the SE side of Hope Valley and midway between Roman Mine and Hope village. Beds high in the Mytton Member were recorded at various points in the vicinity of an old quarry in dolerite, and Whittard's notes for his Loc. 938 state specifically that he had 'not definitely noticed any gradation in softness between Mytton Flags and Hope Shales'.

Between the two principal outcrops of Mytton Member in the Shelve district lies a small, triangular outcrop, bounded to east and west by faults which diverge northwards at an acute angle (Fig. 14). The area is of some interest as it contains numerous exposures and the remains of several workings including Roman Mine which, as the name suggests, was one of the original workings and dates from the second century (Dines 1958). A few typically Mytton fossils such as *Monobolina plumbea* and *Ogygiocaris selwynii* were found at Loc. 711 in micaceous, flaggy, blue-hearted shales which weather light grey. Beds in the highest part of the succession and almost immediately SE of the mapped upper boundary of the Mytton Member were seen at Loc. 927, where they include rocks said to resemble closely the 'Tankerville Flags' of the Stiperstones district, though the latter strata are generally regarded as not being developed in the Shelve district. Similar beds were seen also at Loc. 931. The rocks of the Mytton Member in this area were said to differ from the adjacent Hope Member in several respects: they are harder and more resistant, the contained mica flakes are usually larger, the bedding planes show flatter surfaces, and the edges of flaggy beds are angular and sharper. Spoil heaps (Loc. 934) of material taken from East Roman Gravels Mines, although composed of blue-black flags from the Mytton Member, may cause confusion as they are located on the mapped outcrop of Hope Member. Loc. 929, a short distance to the east, is of interest as it exposes strata of a lithology resembling that at Shelve Church, though no comparable graptoloids have been found. Whittard (1966 : 303) noted the occurrence of this apparently impersistent facies, which he considered to be probably older than that at Shelve, and advocated the rejection of Shelve Church Beds as a stratigraphical subdivision.

Hope Member

First usage. As Hope Shales or Hope Shale Group by Lapworth & Watts (1894 : 316, 317), underlain by Mytton Group and overlain by Stapeley Ashes, a usage approximating apparently to that in the present paper. Lapworth's (1916 : 36) subdivision of the rocks into Lower, Middle and Upper Hope Shales did not pass into general usage.

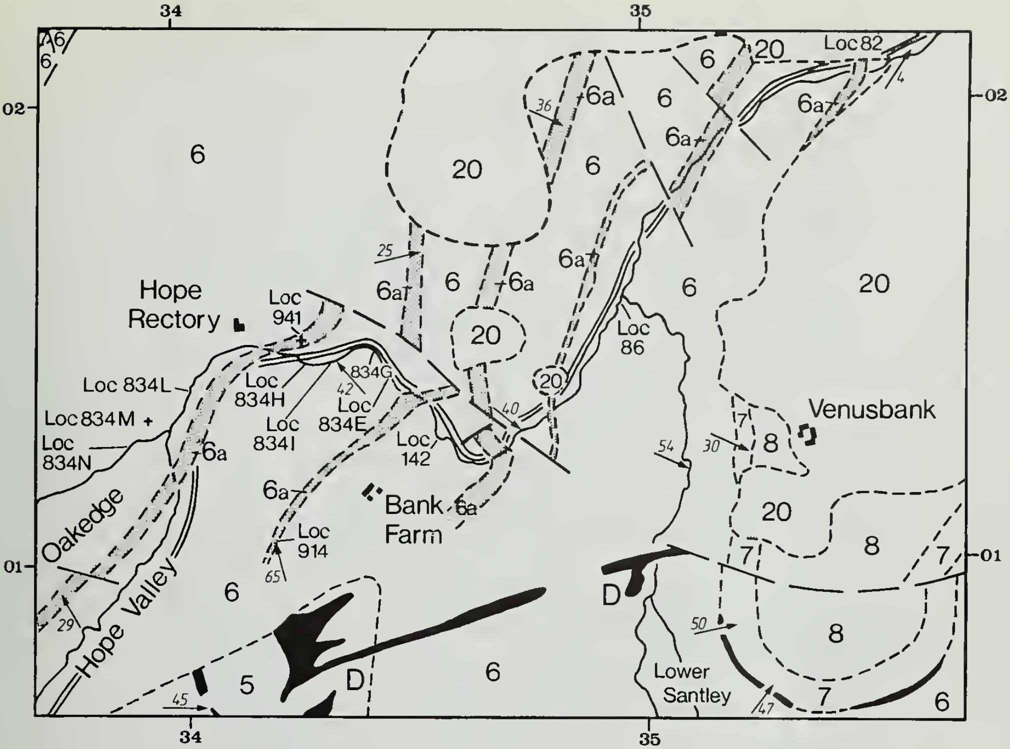

Fig. 15 Geological map of the Hope Valley. Overlaps Figs 14, 16. 5 = Mytton Member; 6 = Hope Member, including 'chinastone' tuff beds (dotted); 7 = Stapeley Volcanic Member; 8 = Stapeley Shale Member; 20 = Silurian rocks; black outcrop D = dolerite. (SJ 30)

Type locality. Hope Valley, near Minsterley (Whittard 1960 : 156), where according to an earlier paper 'practically the whole thickness can be examined' (Whittard 1931 : 327).

Descriptive notes. Whittard (1931 : 327, 328) described the rocks as comprising nearly 800 ft (244 m) of blue-black, rusty-weathering shales containing bands of so-called 'Chinastone Ash', volcanic horizons noted later by him (1960: 156) as 'occasional bands of andesitic tuffs'. The rocks were said to be recognizable only in the Shelve Inlier and were correlated with the *Didymograptus bifidus* Zone of the Llanvirn Series.

Outcrops of the Hope Member are the most extensive of all the subdivisions of the Shelve Ordovician succession, but the rocks weather regressively so that good exposures are not common and the beds often underlie areas of boggy, poorly-drained ground. Their role in the mineralization of the Inlier was noted earlier. The most important outcrops are those of the type area in the Hope Valley (Fig. 15) where the succession includes bands of andesitic tuffs at several levels. Blyth (1938: 397) pointed out that 'dust-tuff' is a more appropriate term for these extremely fine-grained tuffaceous horizons, which have proved locally useful in demonstrating the form of the Shelve Anticline (Whittard 1931*a* : 340). The subject had apparently not been considered in detail by Whittard at the time of his death, and for the present account it is preferred to retain, in spite of its admitted imperfections, the name 'chinastone', which is strongly entrenched in accounts of west Salop geology.

The Mytton/Hope Member boundary near the SE side of Hope Valley was noted earlier and exposures in this area are few, but at Loc. 914 the southern extremity of a thin bed of shattered 'chinastone' was seen to be interbedded with blue, micaceous shales. A section in blue-black shales stratigraphically below this tuff horizon is exposed in the bed of the stream flowing

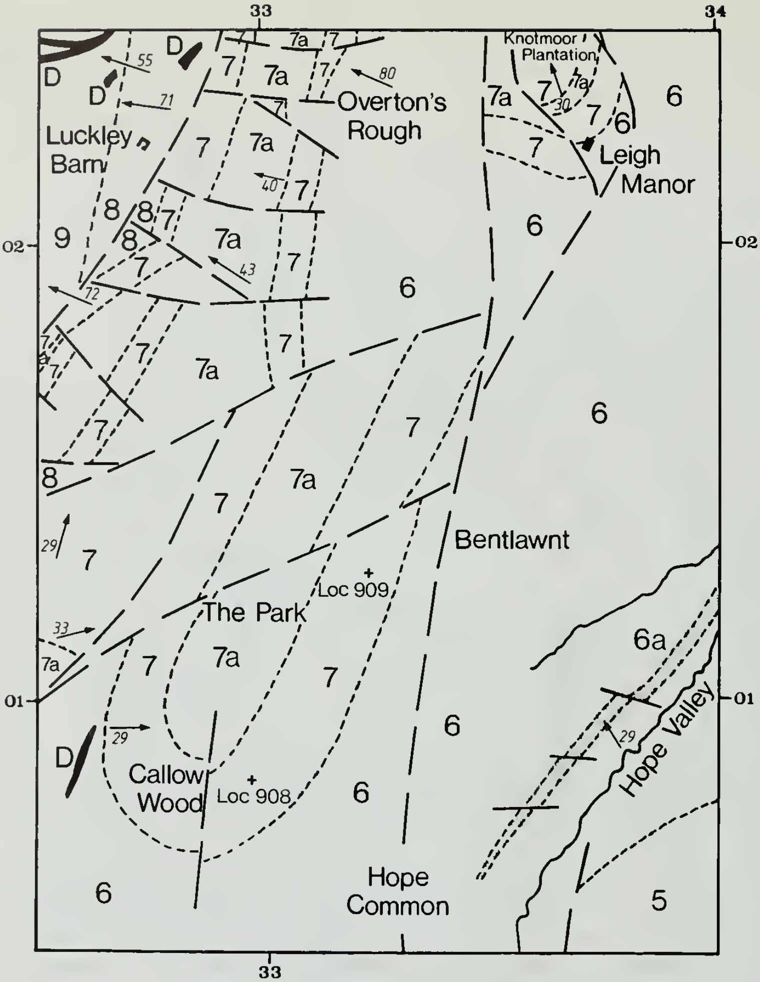

Fig. 16 Geological map of the area between Hope and Overton's Rough. Overlaps Figs 14, 15, 17, 27. 5 = Mytton Member; 6 = Hope Member, including 'chinastone' tuff beds (dotted); 7 = Stapeley Volcanic Member (7a = interbedded shales); 8 = Stapeley Shale Member; 9 = Weston Member; black outcrop D = dolerite. (ST 30)

through Hope Valley *c.* 1500 ft (457 m) SSE of Hope Rectory, where Loc. 142 yielded *Pricyclopyge* and pendent didymograptids (Fig. 15). Farther upstream, shales above the same 'chinastone' are seen in a fairly long section which extends through most of the beds up to the next, and best-known, tuff horizon; fossils, including *Ectillaenus hughesi* (Hicks), *Pricyclopyge binodosa* and *Placoparia*, were found at Locs 834E, G, H and I.

The 'chinastones' have been found with certainty only in the vicinity of Hope hamlet, where there are two major bands (and also smaller, unimportant ones) around the NE-plunging nose of the Shelve Anticline. The first, and higher, band occurs as the faulted backbone of Oakedge (Figs 15–16) and continues down and across the valley to the disused roadside quarry (Loc. 941) adjacent to Ash Cottage and sited 450 ft (137 m) ESE of Hope Rectory. This is the often-visited, so-called 'Contorted Ash Quarry' (see Whittard 1931 : 328) in which the rocks are predominantly bluish-grey, exceptionally fine-grained tuffs with occasional subsidiary bands of shale. From the quarry, the outcrop extends northwards where it is first faulted and eventually ends against the outcrop of unconformable Silurian rocks. The second, lower band is thinner than the first and can be traced in the ridge NW of Bank Farm, into Hope Valley and thence up the northern flank where it makes a pronounced feature which apparently underlies unconformable Silurian strata forming an outlier in the vicinity of the 900 ft (274 m) contour. Both bands of 'chinastone' appear to wedge out to the SW and the upper one also thins to the NE. The large number of exposures of the 'chinastones' clearly indicates that the angle and direction of dip of these rocks are so variable that readings are of only general significance. The quarry near Ash Cottage gives a good impression of the structural condition of the 'chinastones', and their contortions and fracturings are probably a reflection of the structural complication of the shales which contain them. Thin-bedded competent rocks such as these behave as incompetent strata when contained in easily deformed beds such as shales, and the angles and direction of dips in shales of the Hope Member are unquestionably complex. It is thought that the latter rocks behaved as plastic material during the folding of the Shelve Anticline, but the deformation is better indicated by the 'chinastones' as their readings are less prone to modification by hill-creep than are the shales.

Successively higher horizons in shales overlying the upper 'chinastone' are encountered upstream along Hope Brook and the tributary stream running into it from the WSW (Fig. 15, p. 25). Several exposures, including Locs 834L, M and N, are recorded, yielding occasional trilobites (*Barrandia*) and graptolites, and displaying great variation of dip and strike. Downstream from Hope one encounters the succession of shales and 'chinastones' forming part of the southeastern limb of the Shelve Anticline. Fosiliferous shales in Hope Brook at Loc. 86 and the unconformable Ordovician/Silurian junction at Hope Quarry (Loc. 82) were noted by Whittard (1958 : 11).

From Hope Valley the outcrop of the Hope Member extends northwards in a broad strip until it terminates beneath Recent deposits just north of the Brockton – Minsterley road (B.4499). The outcrop (Fig. 17) is cut by conspicuous dolerite intrusions which are irregularly elongated ENE. Exposures are generally uncommon but both the igneous rocks and shales with occasional flags are seen in a stream valley which runs north almost along the centre of the outcrop, where Locs 57–60 yielded trilobites and graptolites.

South-west from Hope Valley, a large outcrop is mapped along the NW flank of Shelve Hill, forming part of the western limb of the Shelve anticline and flooring the poorly-drained areas of Black Marsh and The Marsh. Along the SE side of the Mytton outcrop in the Shelve area, a narrower outcrop of Hope Member forms part of the eastern limb of the anticline, and débris from an old mining level (Loc. 680 – see Fig. 13, p. 22) 300 ft (90 m) north of Shelve Pool yielded a few fossils including *Illaenopsis* and *Pricyclopyge*. The two limbs of the anticline converge to form a single, wide outcrop near the well-known eminence of Corndon Hill, the geology of which was described by Blyth (1944 : 178; pl. 20) whose boundaries for the dolerite phacolith were incorporated by Whittard in the present geological map.

Beyond Corndon, several minor intrusions (Map) of dolerite occur as well as the larger mass of the Cwm Mawr picrite (Fig. 19) described in detail by Blyth (1944 : 187). Apart from the igneous rocks, the most notable place-name in this area is Brithdir farm (Locs 635, 640) where shales of the Hope Member at one time yielded numerous fossils, some of which were illustrated in Whittard's trilobite monograph. The outcrop of the Hope Member terminates at the Silurian unconformity midway between Church Stoke and Snead, but shales were seen in the stream sections at and SW of Llanerch (Locs 603, 605 and 609; Fig. 19) and a few typical fossils were found.

About a mile (1·6 km) ESE of Llanerch lie the southernmost outcrops of the Hope Member in the eastern limb of the Ritton Castle syncline. The rocks, generally poorly exposed, are intruded by the elongated doleritic mass of Disgwylfa (now Squilver) Hill, described by Blyth (1944 : 171) and termed originally the Pitcholds intrusion, after a farm sited farther east and on the outcrop of Mytton Member. Disturbed shales in the highest part of the Member were seen just west of The Hollies farm (Fig. 20) but from there, NE along the strike, the strata are little in evidence, though an old trial shaft in the vicinity of the River West Onny produced a tip-heap (Loc. 254, Fig. 21, p. 32) of poorly fossiliferous, slightly hardened shales.

Beyond the river a narrow strip of Hope Member extends NE alongside the feature formed by the Stiperstones and Mytton Members as far as the south side of The Bog, where the outcrop

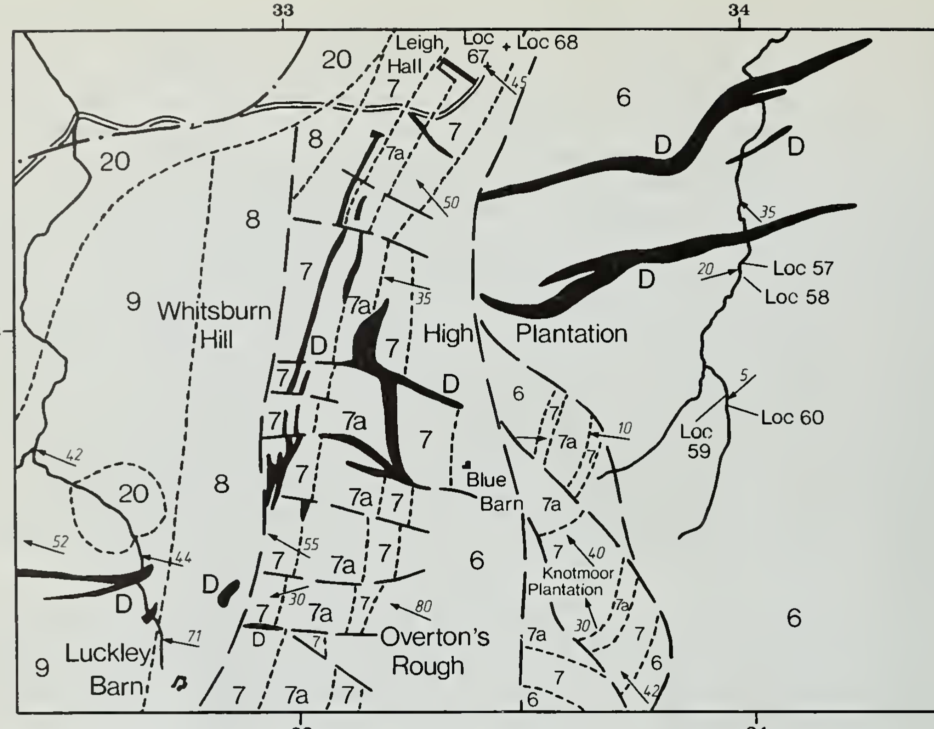

Fig. 17 Geological map of the area between Leigh Manor and Leigh Hall. Overlaps Figs 15, 16, 17. 6=Hope Member; 7=Stapeley Volcanic Member (7a=interbedded shales); 8=Stapeley Shale Member; 9=Weston Member; 20=Silurian rocks; black outcrop D=dolerite. (SJ 30)

suddenly widens and is bounded on its SW side by a fault which cuts out the Stapeley Volcanic and Shale Members. Most of the vicinity of The Bog lacks exposures but a stream flowing west and SW near Ritton Farm and Ritton Castle (Fig. 22, p. 33) shows several exposures of shales, flags and occasional tuffs finally mapped by Whittard as Hope Member, though his notes at one time attributed them to the Stapeley Volcanic Member.

The outcrop around The Bog and, immediately to the north, Pennerley (Map) is shown as being cut medially by an almost north–south fault which then curves slightly NNE coincident with the elongated dolerite intrusion of Buxton Hill (Fig. 7, p. 13) and is intersected by another fault extending from Shelve hamlet NE to Maddox's Coppice (Map and Fig. 11). North-east from Buxton Hill an elongated outcrop has been mapped along the eastern limb of the Ritton Castle syncline, but the junction with the subjacent Mytton Member is not well exposed, though outcrops of the latter are relatively abundant to the east. A quarter of a mile (0·4 km) west of Crowsnest, a stream runs north through Josey's Wood (see Fig. 10, p. 18) and eventually joins Hope Valley Brook. Just SE of the point where the stream cuts the unconformable Silurian rocks (Map), massive, blue-black shales of the Hope Member exposed in the stream valley produced graptolites and trilobites (mostly *Pricyclopyge binodosa* (Salter) but occasionally *Corrugatagnostus* and *Stapeleyella*), a fauna considered at one time by Whittard (1931 : 327) to be especially characteristic of what were then termed 'Lower Hope Shales', a term now superseded.

Little of note was recorded from the remaining outcrop, which extends for about another two miles (3·2 km) before it disappears beneath Recent deposits at a point half a mile (0·8 km) east of Minsterley. The rocks are much obscured by glacial deposits, which attain a thickness of 20 ft (6 m) in a stream section 2000 ft (600 m) NW of Maddox's Coppice, but reappear along the line of the disused Snailbeach railway as it nears Callow Hill (Fig. 12, p. 21), a locality noted

Fig. 18 Corndon Hill, 3 miles (4·8 km) ESE of Chirbury, formed by a resistant dolerite phacolith intruded into regressive Hope (Shale) Member. View looking SW from Squilver.

earlier in connection with rocks of the Mytton Member quarried close by. Doleritic intrusions cut the Mytton rocks just south of the quarry but most of them form a complex area within the outcrop of the Hope Member.

Stapeley Volcanic Member

First usage. By Lapworth (1887 : 662) as Stapeley Volcanic Group, the topmost of three subdivisions of his Stiper Group (Fig. 3, p. 6). In this original usage the term corresponded apparently to the combined Stapeley Volcanic and Stapeley Shale Members of the present paper. The separation and use of the terms Stapeley Volcanics and Stapeley Shales dates from Whittard (1931 : 329), but the latter strata had been differentiated earlier, as Upper Stapeley Shales (now superseded), by Lapworth (1916 : 37). This last work recognized the existence within what is now the Stapeley Volcanic Member of a sequence of three volcanic horizons, separated by 'Lower Shales' and 'Middle Shales'. For these volcanics the names Lower (Hyssington) Ash, Middle (Tashkar) Ash and Upper (Todleth) Ash were introduced, but they did not pass into general use.

Type locality. Stapeley Hill, near Minsterley, according to Whittard (1960 : 254).

Descriptive notes. Rocks of the Stapeley Volcanic Member crop out along the western limb of the Shelve Anticline and are even more extensively developed in both limbs of the Ritton Castle Syncline. The former area includes the type area of Stapeley Hill, $1\frac{1}{4}$ mile (2 km) SE of Rorrington, where a single group of shales separates a lower and an upper set of volcanics, each of which is intruded by a dolerite sill (Map). The succession there dips approximately NW at from 54° to 66° and much of the ground is not well exposed, but mapping of even small faults is facilitated by the features formed by the resistant volcanic rocks.

In the area SW of Stapeley Hill the shales and upper set of volcanics are intruded by the NE extension of the large mass of andesite which forms the greater part of the hill Lan Fawr, three-quarters of a mile (1·2 km) west of Corndon Hill. An additional much faulted area occupied by

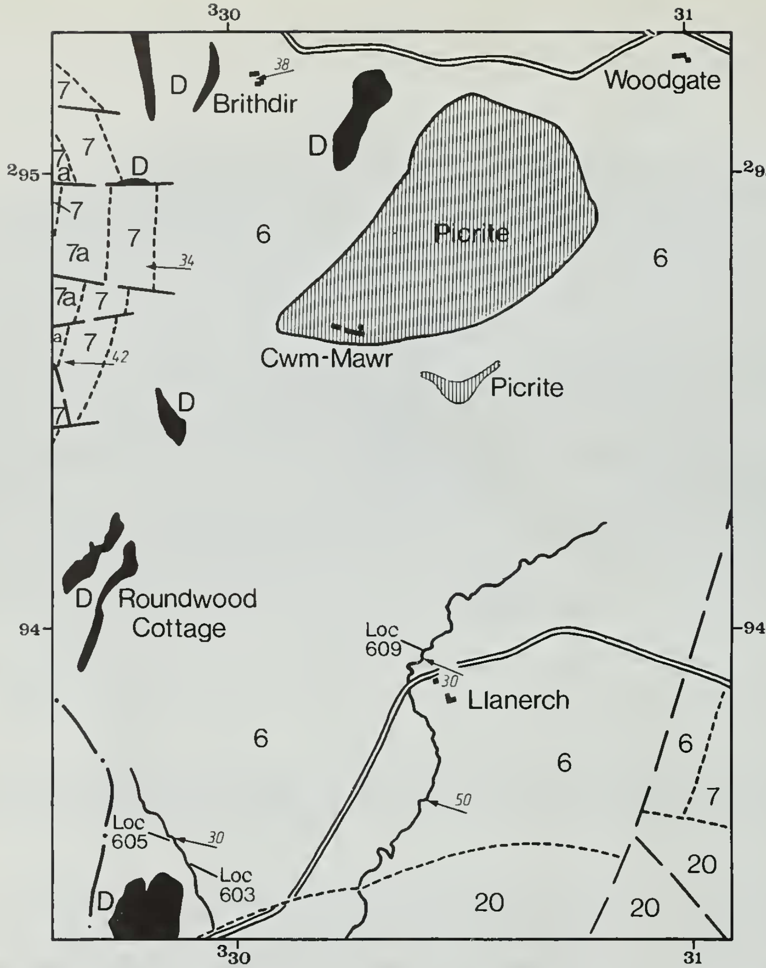

Fig. 19 Geological map of the area west of Hyssington and south of Corndon Hill. Overlaps Fig. 20. 6 = Hope Member; 7 = Stapeley Volcanic Member (7a = interbedded shales); 20 = Silurian rocks; black outcrop D = dolerite; vertically shaded outcrops = Cwm-Mawr picrite. (SO 29, SO 39)

the Stapeley Volcanic Member extends south beyond Lan Fawr and another, slightly larger one runs south along the eastern flanks of the intrusive andesite masses of the hill called Roundton (sometimes written as The Roundtain) and Todleth Hill.

Faulting at the NE end of Stapeley Hill cuts out most of the Stapeley Volcanic Member until one reaches the vicinity of Bromlow Callow and The Park, about a mile (1·6 km) east of Meadowtown (Figs 16, 27, p. 40), where lithic tuffs (including Locs 908–9) are folded into a syncline, truncated to the north by a sigmoidal east–west fault which skirts the south side of Luckley Hill. From there the rocks of the Stapeley Volcanic Member form a strip-like outcrop, 'stepped' at intervals by small faults, which extends (Fig. 17, p. 28) to the northern boundary of the Inlier just north of Leigh Hall (not to be confused with Leigh Manor, a building situated 2620 ft (799 m) at 329° true from the Rectory at Hope). Whittard's map shows the succession within the Volcanic Member north of Luckley Hill to be similar to that of Stapeley Hill, that is with a single shale horizon separating two sets of volcanics. On the other hand at Luckley Hill itself, a fault-bounded area shows apparently a more complex sequence of two shales separating three volcanic horizons, the topmost one of which contains a further subsidiary bed of shale. The apparent incoming of

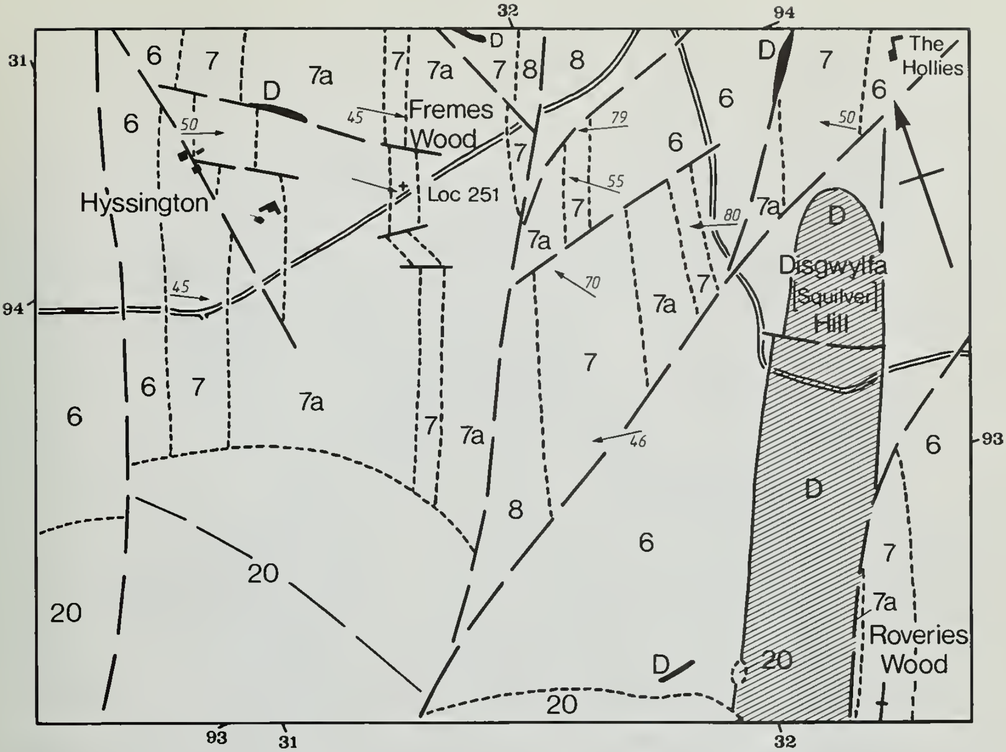

Fig. 20 Geological map of the area SE of Hyssington, in the SE part of the Shelve Inlier. Overlaps Fig. 19. 6=Hope Member; 7=Stapeley Volcanic Member (7a=interbedded shales); 8=Stapeley Shale Member; 20=Silurian rocks; black outcrop D=dolerite. Note particularly also the large dolerite of Disgwylfa (Squilver) Hill, shaded diagonally, and dips indicating the Ritton Castle Syncline. (SO 39)

another volcanic horizon coincides with a southerly widening of the mapped outcrop of the Volcanic Member. In the roadside section just east of Leigh Hall (Locs 67, 68) 'ashes' in the lower part of the Volcanic Member alternate rapidly with rusty-weathering, occasionally fossiliferous, blue-black shales (Fig. 17, p. 28). The evidence of the rocks indicates that the vulcanicity was submarine, probably in short, sudden bursts separated by periods of quiescence whose duration exceeded that of the vulcanicity, so that a benthic fauna could become established.

In the vicinity of Knotmoor Plantation, three-quarters of a mile (1·2 km) NE of Luckley Hill, is a fault-bounded series of outcrops of Stapeley Volcanic Member which according to Whittard's mapping probably include a sequence of at least two volcanic and two shale horizons, the possibility of any higher horizon having been eliminated by faulting (Map). An account by Blyth (1938), based on mapping and excavation of the section NW of Leigh Manor (Figs 16–17), gave an estimated thickness of 417 ft (127 m), made up of two pyroclastic divisions and an intervening group of shales with thin tuffs. Whittard's map shows a similar succession, but the upper pyroclastic rocks form a feature which is succeeded to the NW by a hollow from which the presence of, probably, another shale horizon is inferred. The relationships of the rocks in this complex area are not clear and the above interpretation must be regarded as tentative.

In the SE of the Shelve Inlier, the Stapeley Volcanic Member is encountered first in Roveries Wood, half a mile (0·8 km) NE of Snead (Fig. 20, above) where it forms an elongated, partly fault-bounded outcrop immediately adjacent to the well-known dolerite intrusion which extends NE to form Squilver Hill. The principal area of volcanics commences a short distance to the NW and can be traced to the NE as two parallel series of outcrops, separated by Stapeley Shale

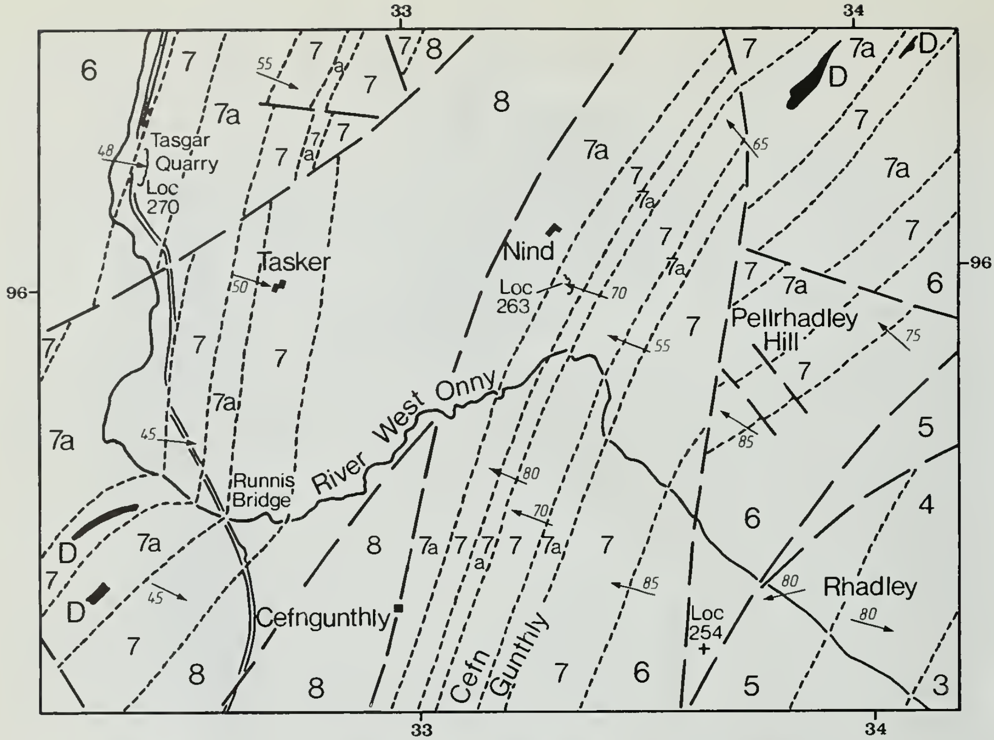

Fig. 21 Geological map of the valley of the River West Onny near Tasgar and Nind. Adjoins Fig. 22. Note dips showing the form of the Ritton Castle Syncline. 3=Shineton Shales; 4=Stiperstones Member; 5=Mytton Member; 6=Hope Member; 7=Stapeley Volcanic Member (7a=interbedded shales); 8=Stapeley Shale Member; black outcrop D=dolerite. (SO 39)

Member forming the core of the Ritton Castle Syncline. The dips of the volcanic rocks show clearly the form of the syncline, but the interbedded shales are less well exposed. Resistant features formed by the volcanics have aided the mapping of numerous faults, including north–south tears and complementary shears which are responsible for a gap in the continuity of the outcrop of the Stapeley Shale Member SE of Hyssington. In this area (Fig. 20) the SE-dipping succession comprises three volcanic horizons separated by shales. Several exposures of the lowest volcanics occur in the immediate vicinity of Hyssington, and rocks of the middle horizon were quarried (Loc. 251) at the south end of Fremes Wood, a quarter of a mile (0·4 km) east of the village, where both tuffs and interbedded shales were seen. Still farther NNE a similar sequence of three volcanic horizons was mapped beyond the valley of the River West Onny at Runnis Bridge, an area in which the most noteworthy locality (Fig. 21) is Tasgar (sometimes Tasker or, rarely, Tashkar) Quarry (Loc. 270), named for the nearby farm. The quarry, once well-known as a fossil locality but now practically worked out, is cut in massive tuffs of the Volcanic Member and the fossils came from subsidiary, interbedded shales.

At the southern end of the eastern limb of the Ritton Castle syncline a sequence of three volcanic horizons and two intervening sets of shales is not readily apparent at first owing to faulting near the north end of Squilver Hill. The sequence is demonstrable along the hill named Cefn Gunthly (or Cefn Gwynlle), 'stepped' at intervals by small transverse faults, and continues across the valley of the River West Onny. A third set of shales mapped at the top of the sequence beside the north end of Cefn Gunthly apparently was regarded as distinct from the Stapeley Shale Member, the outcrop of which is separated by a fault immediately to the west.

Just north of the West Onny, in Nind Wood and some 400 ft (122 m) SSE of Nind (sometimes

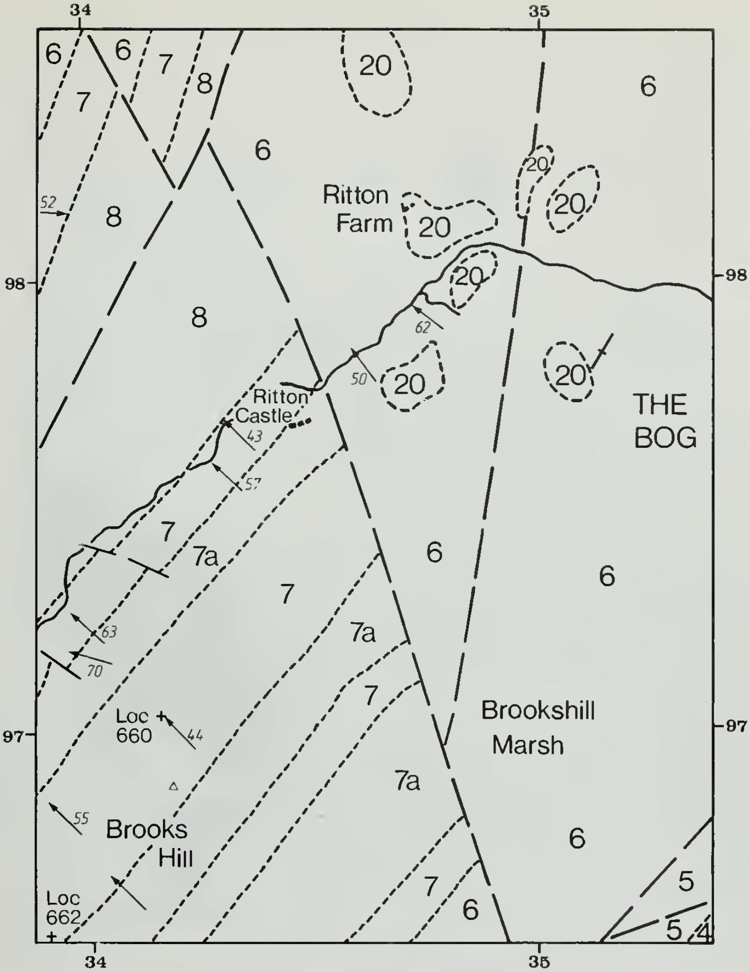

Fig. 22 Geological map of the synclinal area around Ritton Castle and The Bog. Adjoins Fig. 21. Note the small Silurian outliers. 4 = Stiperstones Member; 5 = Mytton Member; 6 = Hope Member; 7 = Stapeley Volcanic Member (7a = interbedded shales); 8 = Stapeley Shale Member; 20 = Silurian rocks. (SO 39)

Nynd or Neint) Farm, is Nind Quarry (Fig. 21, Loc. 263). The section, in the highest of the three volcanic horizons, shows tuffs which sometimes form large, nodular masses, weathering to a gingerbread colour, and may possibly have been calcareous. Interbedded shales at one time yielded numerous fossils, but collecting is not now profitable.

The volcanics of the Nind area are truncated a short distance to the east by one of the Inlier's conspicuous north–south tear-faults which runs between Cefn Gunthly and Black Radley Hill and skirts the western margin of Heath Mynd. Beyond the fault-line, at and near Brooks Hill, three-quarters of a mile (1·2 km) NE of Nind Quarry, Whittard's mapping (Fig. 22) shows the outcrop of the Stapeley Volcanic Member to be decidedly broader, with four volcanic horizons separated by shales. Even this appears to be a somewhat generalized picture and the notes on Loc. 660, 530 ft (162 m) at 348° true from the summit of Brooks Hill, emphasize the difficulty of distinguishing a detailed sequence of shale bands and tuffs in badly-exposed terrain. At this point the dip-slope of the Volcanic Member, instead of presenting a uniform appearance, exhibits two narrow 'benches' which can only be assumed to mark shaly horizons, though the

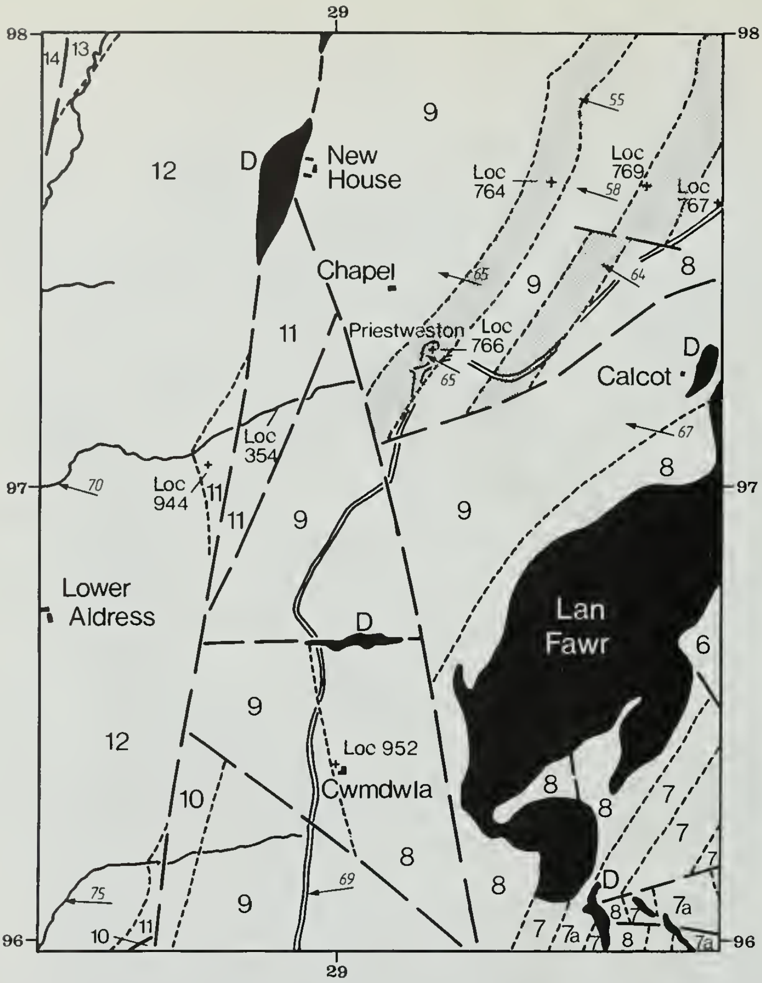

Fig. 23 Geological map of the Priestweston area and the andesitic intrusion of Lan Fawr. Adjoins Fig. 24; overlaps Figs 30, 32. 7 = Stapeley Volcanic Member (7a = interbedded shales); 8 = Stapeley Shale Member; 9 = Weston Member, including 'grit' horizons (dotted); 10 = Betton Member; 11 = Meadowtown Member; 12 = Rorrington Member; 13 = Spy Wood Member; 14 = Aldress Member; black outcrop D = dolerite; main black outcrop = andesite. (SO 29)

hillside is bracken-covered and there is little evidence of rock except for widely dispersed blocks of tuff. The observation is recorded to emphasize the importance within the volcanics of shale bands which may range in thickness from several yards (metres) to 1–2 in (2·5–5 cm) in extreme cases. The note goes on to speculate that it may eventually prove necessary not to separate (what is now) the Stapeley Shale Member from the Volcanic Member, but no such action was ever taken by Whittard. Loc. 662, on the SW side of Brooks Hill and 1400 ft (427 m) at 217° true from the summit, is of particular interest as Whittard described the low, cliff-like section there as showing interbedded, coarse-grained lithic tuffs, crystal tuffs and ashy shale, varieties of rock which recalled the beds near Leigh Manor described in 1938 by Blyth (see p. 31). The wide outcrop of the Volcanic Member extends NE of Brooks Hill for another half mile (0·8 km) and is then truncated by a prominent NNW–SSE fault.

The Stapeley Volcanic Member in the western limb of the Ritton Castle syncline extends NE to a point half a mile (0·8 km) NE of Shelve hamlet. The outcrop is truncated by faulting but in addition the sequence is much attenuated and only a single volcanic horizon was mapped there, overlain by the Stapeley Shale Member. After a gap of 1460 yd (1·34 km) along the strike, the outcrop reappears in a small area NE of Lower Santley, SE of Hope. There also a single volcanic horizon was mapped, succeeded apparently by the Stapeley Shale Member (though poorly exposed and its outcrop largely inferred), the two subdivisions together being in the form of a small syncline, unconformably overlain by the Lower Silurian strata of the Venusbank district (Fig. 15, p. 25). In this area the map of Lapworth & Watts (*in* Pocock & Whitehead 1948 : pl. 11) shows a very large outcrop of Stapeley Volcanics on ground that is now known to be occupied largely by Silurian rocks.

Stapeley Shale Member

FIRST USAGE. As Upper Stapeley Shales, by Lapworth (1916 : 37). Subsequently modified to Stapeley Shales by Whittard (1931 : 323) and so used by him in later publications.

TYPE SECTION. Chosen by Whittard (1960 : 254), who described the beds as usually unfossiliferous; Holywell Brook, NW of Stapeley Hill and 1·75 miles (2·4 km) NNW of Shelve hamlet. Earlier Whittard (1952 : 159) noted an upward gradation from the Stapeley Shales into the Weston Beds at Holywell Burn (=Brook), so that an arbitrary boundary between the two had to be chosen.

DESCRIPTIVE NOTES. The strata of the Member are typically 'bluish-grey, rusty-weathering, soft shales' (Whittard 1931 : 330) and crop out within two elongated areas which form the western limb of the Shelve Anticline and the core of the Ritton Castle Syncline. Good continuous sections through the Shale Member are rare and even Holywell Brook, the type section, exhibits only the upper portion clearly, although the underlying Stapeley Volcanic Member crops out not far away (Fig. 25, p. 37). At this point Holywell Brook arises on the NW side of the north end of Stapeley Hill in an area of swampy ground with no solid outcrop, and it is not until the stream meets the west side of Valley Knoll that exposures of the Stapeley Shale Member are encountered. Here and in the stream section separating Valley Knoll from Rorrington Hill are seen strata interpreted as the highest of the Shale Member, dipping NNW at 50°–60° and succeeded by Weston Member. Whittard's arbitrary selection of the boundary has already been noted and was taken near the western end of an outcrop (Loc. 462) elongated east–west beside the northern bank of Holywell Brook, just west of its confluence with the tributary stream flowing from the SSE (Fig. 25, p. 37). At the western end of this outcrop were seen flaggy beds that could be assigned without much hesitation to the succeeding Weston Member, but farther east the rocks are more shaly with bands up to 2 in (5 cm) thick of micaceous shale resembling the typical lithology of the Stapeley Shale Member. The latter also show an anomalous increase of dip which is thought to be due to more than landslipping, and an almost continuous section (Loc. 463) along part of Holywell Brook farther east also exhibits variations in dip and strike. It is possible that such discrepancies may be the result of a fault running through the badly-exposed area of Rorrington Covert, and Whittard's notes show that he was considering an alternative interpretation which is shown in Fig. 26, p. 37. The lithological transition from Stapeley Shale Member to Weston Member is reflected to some degree in the type of fauna present; ogyginid trilobites are present in both subdivisions but the Weston Member contains a bivalve and lingulid brachiopod fauna which is almost unknown in the underlying Shale Member.

Some 1·62 miles (2·6 km) SSW of Holywell Burn, a road section (Loc. 767) NE of Priestweston (Fig. 23) cuts through part of the highest third of the Member and is of interest as it demonstrates the gradual appearance of more flagstone beds until the arbitrary base of the Weston Member is reached, in this instance at a point closer to Priestweston.

In the area between Priestweston and Holywell Brook the boundary of the Stapeley Volcanic and Shale Members runs NE along the edge of Stapeley Hill but is not generally visible. Of particular interest, therefore, is a section in the lower portion of the Shale Member at an old mining adit (Loc. 453) situated 2400 ft (732 m), 282° true from Stapeley Farm (Fig. 24). The beds of the Shale Member here are rusty-weathering, dark, bluish-grey shales, with occasional spheroidal concretions, and an apparently unfaulted thickness of 198 ft (60·35 m) was measured

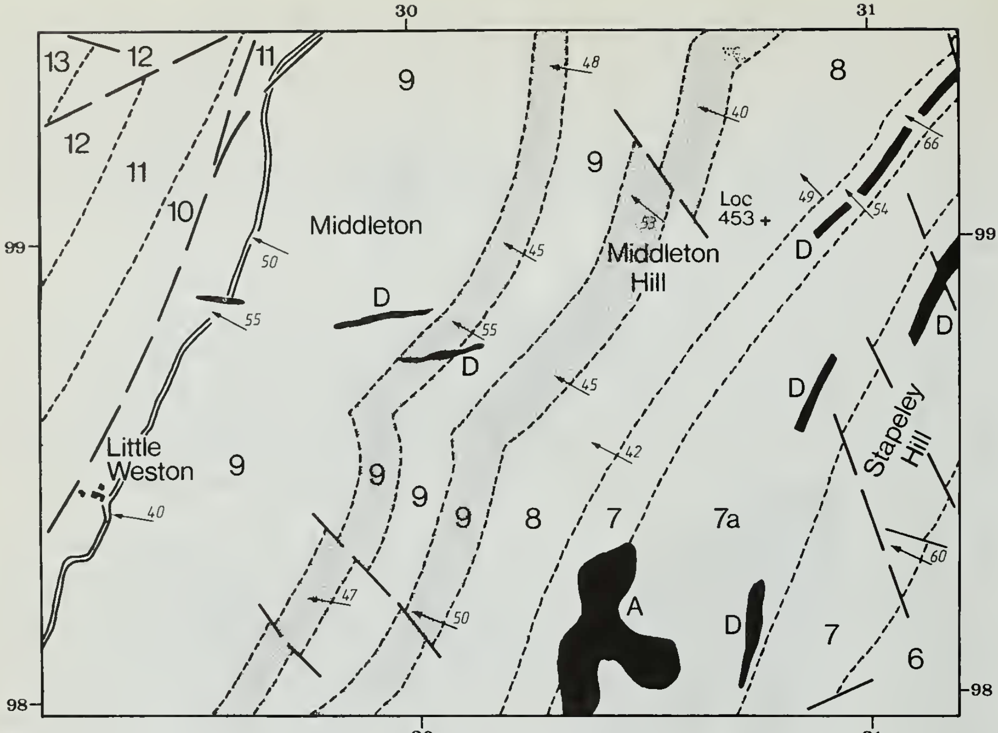

Fig. 24 Geological map of the area NE of Priestweston. Adjoins Fig. 23; overlaps Figs 25, 29. 6 = Hope Member; 7 = Stapeley Volcanic Member (7a = interbedded shales); 8 = Stapeley Shale Member; 9 = Weston Member, including 'grit' horizons (dotted); 10 = Betton Member; 11 = Meadowtown Member; 12 = Rorrington Member; 13 = Spy Wood Member; black outcrop D = dolerite; black outcrop A = andesite of Lan Fawr. (SO 29, SO 39)

along the adit. A normal contact with the underlying Volcanic Member was demonstrated by a junction bed 5 ft (1·52 m) thick, comprising an alternation of shales and tuffs and indicating a gradual passage between the two members.

Outcrops of the Stapeley Shale Member extend intermittently southwards from Priestweston for 2 miles (3·2 km) until they are terminated by glacial deposits just south of the village of Hurdley. An elongated hollow between Todleth Hill and Roundton (Map) has been mapped in part as a NW extension of the outcrops of Shale Member which run along the eastern margin of the intrusive masses of andesite. The rocks are exposed at various points along the northerly-trending stream NW of Hurdley and graptolites of 'tuning-fork' type were collected at Loc. 624. Exposures are poor along the eastern margin of Todleth Hill, but shales belonging to the Member were found in an excavation for a water-pipe near the north end of the hill.

Still forming part of the western limb of the Shelve Anticline, the outcrop of the Stapeley Shale Member extends NE for about $2\frac{1}{2}$ miles (4 km) before ending beneath the unconformable cover of Lower Silurian strata which marks the northern boundary of the Shelve Inlier in the vicinity of Leigh Hall, a mile (0·6 km) south of Worthen (Fig. 17, p. 28). The outcrops in this structurally more complex area are discontinuous and the rocks are not well exposed.

In the eastern part of the Shelve Inlier, rocks of the Stapeley Shale Member form an elongated outcrop, often broken by faults, which extends ENE along the axis of the Ritton Castle Syncline from a point 0·62 mile (1 km) north of Snead (Map) for a distance of $4\frac{1}{2}$ miles (7·24 km) to Round Hill, near Pennerley. The rocks are indifferently exposed and no noteworthy sections or localities are recorded. A further outcrop is largely inferred to the NW of Lower Santley, 0·42 mile (0·67 km)

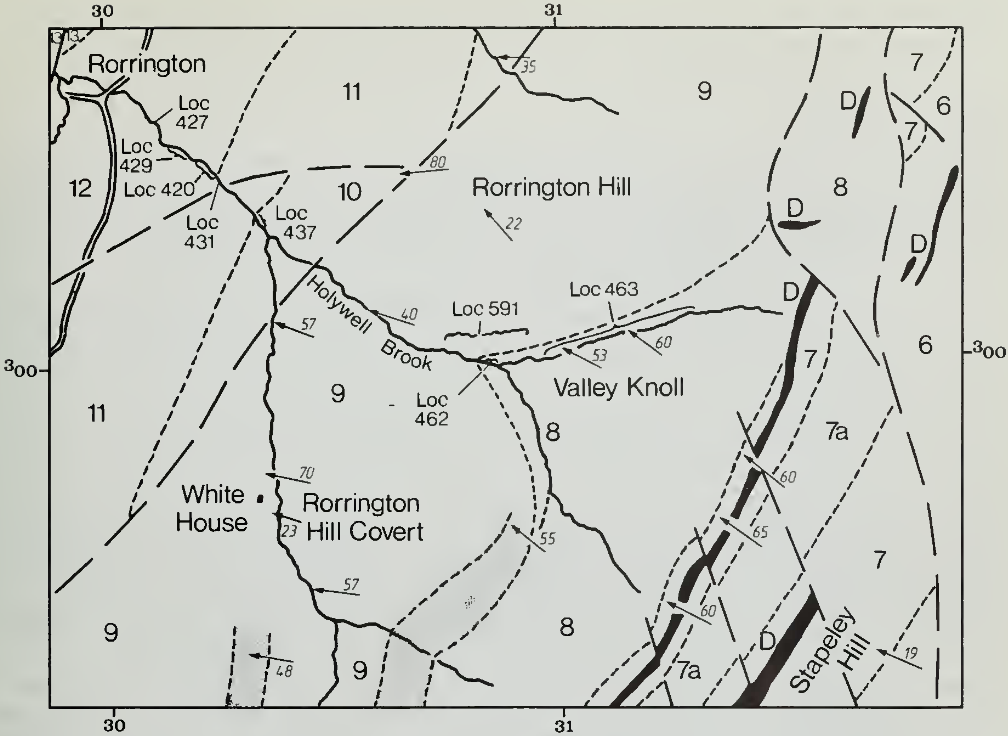

Fig. 25 Geological map of the area around Holywell Brook, SE of Rorrington. Overlaps Figs 24, 27, 28, 31. 6=Hope Member; 7=Stapeley Volcanic Member (7a=interbedded shales); 8=Stapeley Shale Member; 9=Weston Member, including 'grit' horizons (dotted); 10=Betton Member; 11=Meadowtown Member; 12=Rorrington Member; 13=Spy Wood Member; black outcrop D=dolerite. (SO 39, SJ 30)

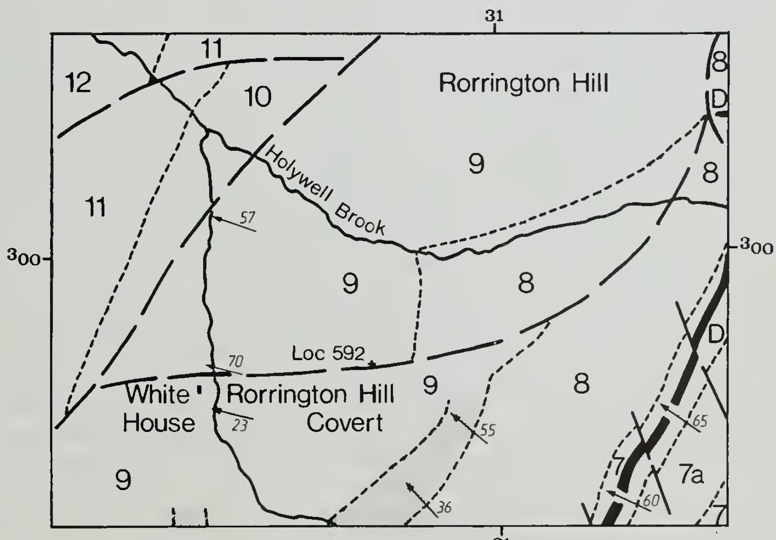

Fig. 26 Alternative interpretation of the area around Holywell Brook; beds as in Fig. 25. Heavy mineralization of rocks at Loc. 592 suggests the proximity of a fault. (SO 39, SJ 30)

SSW of Venusbank (Fig. 15, p. 25). The shales there are underlain by folded and faulted tuffs of the Stapeley Volcanic Member and overlain by unconformable strata of Llandovery age.

Middleton Formation

First usage. As Middleton or Llandeilo Series, by Lapworth & Watts (1910 : 752, 753), underlain by Shelve Series and overlain by Chirbury Series. Made up of successive subdivisions of Weston Flags and Shales (or Stage), Betton or *Didymograptus murchisoni* Shales, Meadowtown Calcareous Beds (or Stage) and Rorrington Shales, the term replaced without comment the earlier-named Meadowtown Series of Lapworth (1887 : 662).

Type locality. Presumably the vicinity of the hamlet of Middleton, $2\frac{1}{2}$ miles (4 km) due west of Shelve, but no type section was designated.

Weston Member

First usage. As Weston Group, by Lapworth (1887 : 662), apparently in the same sense as now employed.

Type locality. 'Priestweston hamlet' was designated by Whittard (1960 : 281) in the *Lexique Stratigraphique International*, where he described the constituent rocks as being 'divided into a lower and upper group of massive greenish-brown grits, separated by rusty-weathering, blue-hearted shales'. This description almost exactly matched one given earlier by him (1931 : 330) except that the 'shales' were listed as 'flags'. In his notes Whittard referred to the old quarry at Priestweston as being the type locality, but with reservations that are discussed later.

Descriptive notes. The rock types within the Weston Member include siltstone, flagstone and tuff, while shale is only rarely developed. One of the characteristics of the more argillaceous strata is that they seldom present a surface sufficiently flat for measuring the dip. The almost total absence of soft shales is a useful factor in distinguishing the rocks from those of the Stapeley Shale Member and the smoothness of the flat, fresh surfaces of the latter beds finds no parallel in the Weston Member. Consequently, even though the boundary of the two members is arbitrarily taken, and there is a gradation through *c.* 20–30 ft (6–9 m) of rock, it is fairly easy to distinguish those belonging to the Weston Member. The strata appear to represent ill-sorted, extremely shallow water deposits which might even be near estuarine in origin. In places they were apparently laid down under turbulent conditions, as shown by the remarkably rapid and irregular alternations of wisps of argillaceous matter within siltstones. Furthermore, the rocks are not generally fossiliferous, but in places they are richly so. Some fossil localities are in the more shaly beds, others are less richly fossiliferous in thin flagstones, others include the occasional occurrences in massive beds, and yet others are associated with tuffaceous layers in which graptolites are not infrequent. The latter may be taken to indicate other than near-estuarine conditions, but it was not unusual for graptolites to enter shallow coastal waters and if they were epiplanktonic no doubt detached masses were sometimes washed into littoral zones. What is more significant is that whenever the beds are found to be fossiliferous, by far the most important elements in the fauna are the bivalves, horny brachiopods and, less commonly, gastropods. Other forms are trilobites, mainly *Ogyginus corndensis* (Murchison), a few nautiloid cephalopods, rare crinoids and some articulate brachiopods. This fauna is not one typical of the shallow waters of the Ordovician sea, and its association with ill-sorted sediments suggests estuarine conditions.

Within the whole outcrop of the Weston Member there are subsidiary escarpments, sometimes pronounced. These scarps are not so much owing to the alternation of soft rocks with much harder ones as to variation in the proportions of grits, flags and shales developed in an interbedded series. Even in the less resistant divisions, alternation of rock-types persists. In some cases the main resistant horizons can be mapped for a moderate distance across country, but in others a single horizon may quickly be replaced by more than one. It is evident that the Weston Member, on both the large and the small scale, is composed of constantly-changing, lenticular strata, a view not inconsistent with deposition in a very shallow water environment.

Outcrops of the Weston Member are confined to the western limb of the Shelve Anticline, where they occupy a strip of country up to about half a mile (0·8 km) wide which extends NNE from a point three-quarters of a mile (1·2 km) ESE of Church Stoke, by way of Priestweston, to terminate at the northern boundary of the Inlier between Betton and Leigh Hall (Map). The most southerly section occurs in an old quarry (Loc. 406), situated near Hoarstone Farm and 4350 ft (1326 m) at 114° true from St Nicholas's church, Church Stoke. In this area the rocks are flaggy, with a high percentage of coarse-grained volcanic dust, and in places there are thin beds of flinty, vitric tuffs and occasional intercalations of soft, friable tuffaceous material. The outcrop narrows northwards between the andesitic mass of Todleth Hill, to the east, and the Quaternary deposits of the Church Stoke area, but widens to the north of Old Church Stoke and underlies the flat ground south and east of Upper Aldress (Map).

A little farther north is Cwm-Dwla (sometimes Cwmdulla) farm, just west of the SW end of Lan Fawr hill (Fig. 23, p. 34), which is of importance as it provides one of only two places (the other is Holywell Brook – see p. 35) where the passage from Stapeley Shale Member to Weston Member can be studied. The section (Loc. 952), situated just behind and north of the farm, shows the Shale Member comprising light-grey weathering, silky shales, dark grey when fresh and interbedded with flags and tuffs which vary in thickness from less than an inch (25 mm) up to 10 in (250 mm). These harder beds appear to increase in importance higher in the succession and eventually give place to the typical Weston Member lithology, with its appearance of argillaceous matter whisked up with silty material.There is no indication of a sedimentary break and, as at Holywell Brook, the succession is undoubtedly continuous. The area immediately north and east of Cwm-Dwla is interpreted as part of a fault-bounded, angular outcrop which includes also Stapeley Shale Member and is truncated to both north and south by transverse faults, the northerly of which coincides with a dolerite intrusion elongated east–west.

Farther north again lies the hamlet of Priestweston, said to be the type locality for the Weston Group and consequently presumed to be that for the Weston Beds (now Weston Member), although in practice only a fraction of the succession is found there. Whittard noted that the old quarry (Loc. 766) at Priestweston might be taken as the type-section but observed that in a sense this would be misleading since it exposes no more than 90 ft (27·5 m) of rock and is excavated in the hardest, flaggy beds, most suitable for local building. There is no indication of the less resistant beds which go to make up so much of the succession elsewhere and which are not infrequently fossiliferous, whereas the massive beds seldom provide fossil remains and probably accumulated under conditions inimical to animals. For the most part the rocks are flaggy, highly micaceous, sometimes ripple-marked, and interleaved with thin siltstones. On the eastern, dip face the surface is literally covered with fucoid markings where the rock face is markedly micaceous. The fucoids are compressed, unbranched, rod-like structures; they show no particular alignment but may cross one another.

The rocks at Priestweston Quarry were mapped by Whittard as part of the upper of two 'grit' horizons which occur in approximately the lower half of the Member and can be traced NNE for almost 2 miles (3·2 km) before apparently dying out in the vicinity of Rorrington Hill Covert, near Holywell Brook (Fig. 25). The 'grit' of Priestweston Quarry crops out *c.* 1700 ft (518 m) NE of the hamlet, in the sides (Loc. 764) of the subsidiary road running NE from the Methodist chapel, and thence to and just beyond the small valley of Cwm Dingle. Farther NE the outcrop is cut by small, transverse faults; it and the overlying strata are intruded by two east–west dolerite dykes about 1800 ft (549 m) WSW of Middleton Hill. The lower 'grit' horizon crops out just SE of Priestweston, in the vicinity of what was once the Miners Arms inn, and continues parallel to the outcrop of the higher 'grit', though extending a little farther (Map), and forms a feature to the SE of Rorrington Hill Covert. The argillaceous strata between the two 'grit' horizons, though infrequently exposed, were seen in a pathside exposure (Loc. 769) 1850 ft (564 m) at 046° true from Priestweston Quarry (Fig. 23, p. 34).

Between Rorrington Hill Covert and Rorrington Hill runs the valley of Holywell Brook, to the north of which (Fig. 25) is a low, cliff-like outcrop (Loc. 591) formed by rocks in the lower part of the Weston Member. The section is so variable that detailed measurements are not practicable, but *c.* 40 ft (12·2 m) of rock are exposed in the cliff, composed of coarse, tuffaceous

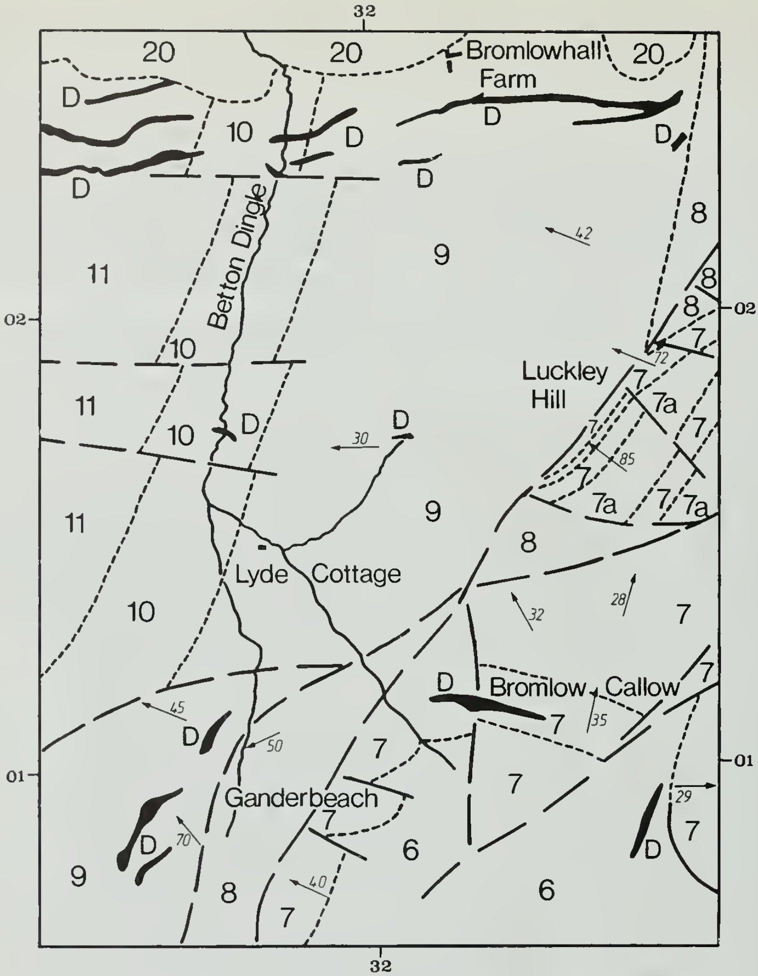

Fig. 27 Geological map of the area around Betton Hill and Luckley Hill, east of Meadowtown. Adjoins Fig. 28; overlaps Figs 16, 17, 25. 6 = Hope Member; 7 = Stapeley Volcanic Member (7a = interbedded shales); 8 = Stapeley Shale Member; 9 = Weston Member; 10 = Betton Member; 11 = Meadowtown Member; 20 = Silurian rocks; black outcrop D = dolerite. (SJ 30)

flags, finer tuffaceous flags showing curvilinear banding, and knobbly-weathering silty shales. It would seem that the massive beds of the Weston Member owe their massiveness to included volcanic débris, without which the rocks would probably have been deposited as muds and silts. Immediately west of the cliff, an old quarry adds *c.* 40 ft (12·2 m) to the thickness exposed there and is stratigraphically beneath it. The quarry face is mainly built up of fine-grained massive rocks in which small lenses of apparently more tuffaceous material weather more readily.

From Rorrington Hill the outcrop of the Weston Member narrows northeastwards as the result of faulting in the area east of Meadowtown, and then widens again between Lyde and Bromlow (Fig. 27) before being terminated by unconformable Lower Silurian strata between Betton and Leigh Hall. The passage from Weston Member to Betton Member in the stream section near Lyde Cottage (Fig. 27) is assumed to be normal and gradational though the actual junction seems somewhat arbitrary. The angle formed by this stream and a subsidiary one at a point 150 ft (45·7 m) SSE of Lyde Cottage exposes a section in brown-weathering, nodular strata of the Weston Member. This exposure was particularly noted by Whittard (1958 : 13) as showing shales which elsewhere are interbedded with massive flags and which here are unusually fossiliferous.

Betton Member

FIRST USAGE. As Betton or *Didymograptus Murchisoni* Shales by Lapworth & Watts (1910 : 752, 753). The rocks were said to yield an abundance of *D. murchisoni* and *Orthis*, and to be best exposed SE of Rorrington. They were later termed *Didymograptus murchisoni* Beds, equivalent to a Betton Group or Stage, by both Lapworth (1916 : 36) and Watts (1925 : 340), but the name Betton Beds was introduced by Whittard (1931 : 323) and retained by him thereafter.

TYPE SECTION. Betton Dingle, NNE of Meadowtown (Fig. 27), according to Whittard (1960 : 52).

DESCRIPTIVE NOTES. The beds were described by Whittard (1931 : 331; 1960 : 52) as micaceous, blue-black shales and flags with a thickness of 600 ft (183 m), a figure notably larger than the 200 ft (61 m) give earlier by Watts (1925 : 340). Junctions with the underlying Weston Member and overlying Meadowtown Member were said to be apparently gradational.

Lapworth & Watts' geological map of the Shelve Inlier (*in* Pocock & Whitehead 1948 : pl. 11) indicated the outcrop of the 'Betton Shales and Flags' as forming a narrow, unbroken, band-like outcrop which extended SSW from the vicinity of Betton farm to reach the southern boundary about three-quarters of a mile (1·2 km) SE of Church Stoke. Whittard's mapping demonstrated that the outcrop is, in fact, broken into three discrete portions as a result of the north–south tear-faults which affect the Inlier.

The northernmost outcrops of Betton Member occur (Fig. 27) in the vicinity of Betton Dingle, which runs NNE almost along the strike in the area SSE of Betton farm. Only here is the succession complete, with both upper and lower boundaries unaffected by faulting. A conspicuous feature of the outcrops immediately south of the margin of the Inlier, here comprising unconformable Silurian strata, is the presence of narrow, subparallel dolerite intrusions, members of a group which are elongated east–west in the area between Overton's Rough and Lower Wood. The predominantly strike section in Betton Dingle exhibits little variation in lithology. The general rock type is a micaceous, rusty-weathering, blue-hearted shale occasionally interbedded with more siliceous layers which pass into flags, not infrequently colour-banded blue-grey and light grey. At other times volcanic detritus is obviously present, producing coarser-grained rocks.

From here the outcrop continues SSW until level with Meadowtown hamlet, where it is obliquely truncated by a fault so that the outcrop narrows and finally disappears half a mile (0·8 km) east of Rorrington. Exposures of Betton Member are recorded (Fig. 28) from the lane (Loc. 577) 600 ft (183 m) SSE of Meadowtown Quarry, where pendent didymograptids were found, as well as in the fields SW of this point. Loc. 505, 1300 ft (396 m) SW in the stream skirting the north side of Rorrington Hill, shows an exposure in blue-black shales which yielded ogyginid and trinucleid trilobites. Whittard noted that the section here (assuming a uniform dip) contains a thickness of 440 ft (134 m) of Betton Member, a figure comparable with that in Holywell Brook; this is considerably less than the 600 ft (183 m) given elsewhere by Whittard for the Member, but the succession here is incomplete owing to faulting.

The southern continuation of this outcrop is 'stepped' westwards by a fault and the rocks are seen next in the small valleys cut by Holywell Brook and Whitehouse Brook, the stream running north along the western margin of Rorrington Hill Covert (Fig. 25, p. 37). Immediately north of (i.e. downstream from) the junction of the two is a section (Loc. 437) in shales, flaggy and tuffaceous shales, and thin, 1–3 in (2·5–7·5 cm) tuffs, the last containing angular fragments and abundant pyrite. The rocks yielded a varied fauna comprising *Didymograptus* of *murchisoni* type and trilobites (*Ogyginus*, *Bettonia* and *Trinucleus*). The apparent thickness of 400 ft (122 m) is again low because of faulting, as a result of which the next set of outcrops is found farther SW, underlying a wedge-shaped area to the west and, especially, north of Priestweston (Map). The area is not well exposed but at Loc. 307 (Fig. 29), in the stream-section 990 ft (302 m) WSW of Little Weston, may be seen blue-hearted flaggy beds with some very thin, shaly partings; these contain a fauna similar to but less abundant than that at Loc. 437.

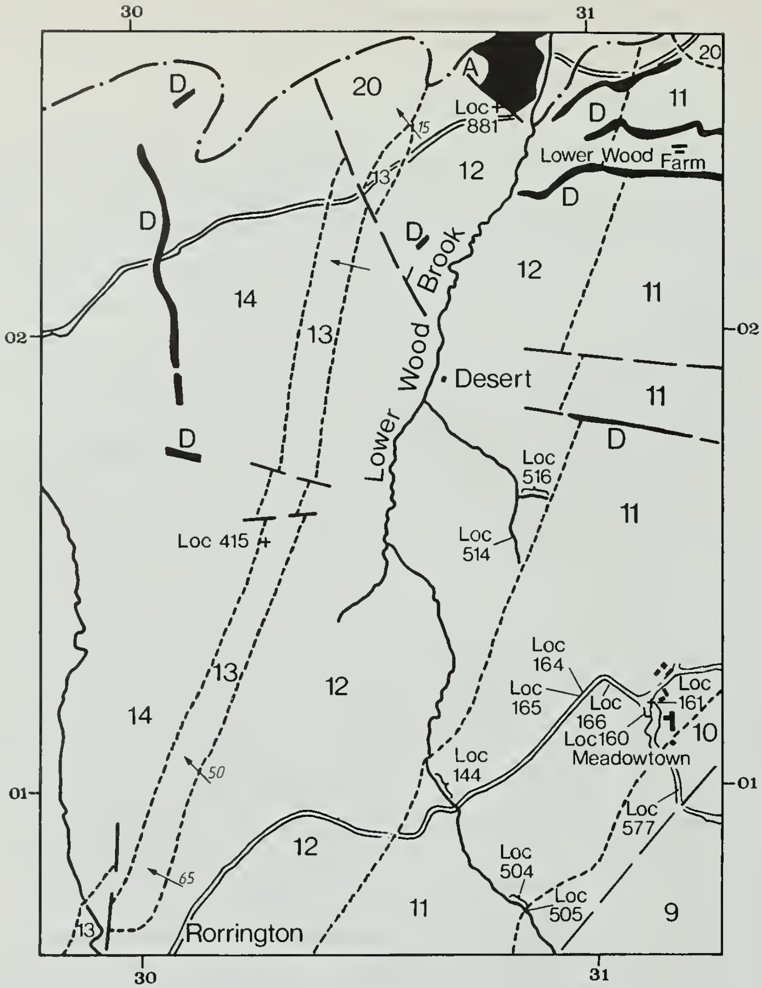

Fig. 28 Geological map of the area NW of Meadowtown, including Lower Wood Brook. Adjoins Fig. 27; overlaps Fig. 25. 9 = Weston Member; 10 = Betton Member; 11 = Meadowtown Member; 12 = Rorrington Member; 13 = Spy Wood Member; 14 = Aldress Member; 20 = Silurian rocks; black outcrop D = dolerite; black outcrop A = andestic intrusion of Lower Wood (SJ 30)

The sole remaining outcrops of Betton Member occur in two small, immediately adjacent and largely fault-bounded areas centred about half a mile (0·8 km) north of Church Stoke, where the southerly continuation is terminated by glacial deposits forming the southern boundary of the Inlier. The original interpretation of this area was subject to some later revision by Whittard, and the present map represents his final version.

The uppermost (i.e. easterly) reaches of Spy Wood Brook expose sandy, argillaceous, flaggy beds with much volcanic dust and pyrite at Loc. 382 (Fig. 30). Fossils are not common but include *Ogyginus*, trinucleids, fragments of inarticulate brachiopods and poorly-preserved biserial graptolites. About 750 ft (231 m) farther south, the last outcrops of Betton Member are seen in the small valley known locally and in Whittard's Monograph and notes as Deadman's Dingle, which runs westwards into Spy Wood Brook. Several exposures, including Loc. 385, of micaceous, flaggy shales occur, some of which contain a typical fauna of graptolites and trilobites, while Loc. 384, in the lower part of the succession, shows *c.* 18 ft (5·5 m) of rusty-weathering shales rich in volcanic detritus.

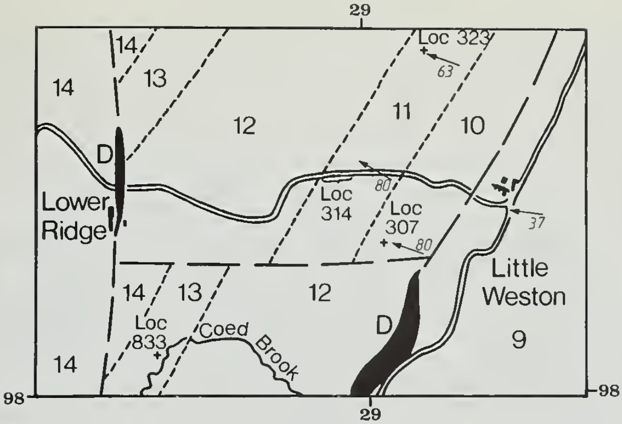

Fig. 29 Geological map of the area between Lower Ridge and Little Weston, including the upper reaches of Coed Brook. Adjoins Figs 23, 34; overlaps Fig. 24. 9 = Weston Member; 10 = Betton Member; 11 = Meadowtown Member; 12 = Rorrington Member; 13 = Spy Wood Member; 14 = Aldress Member; black outcrop D = dolerite. (SO 29)

Meadowtown Member

FIRST USAGE. As Meadowtown Calcareous Beds or Meadowtown Stage, by Lapworth & Watts (1910 : 752, 753). Equivalent to the Meadowtown Group of Lapworth (1916 : 36), later renamed Meadowtown Beds by Whittard (1931 : 323). Further subdivisions of the Meadowtown Group listed by Lapworth (1916 : 36) have not survived. The term should not be confused with 'Meadowtown Series' as used by Lapworth (1887 : 662), a much larger subdivision which is equivalent to the present Middleton Formation.

TYPE LOCALITY. 'Meadowtown hamlet' according to Whittard (1960 : 183), no specific type section being designated.

DESCRIPTIVE NOTES. The rocks were described briefly by Whittard (1931 : 331; 1960 : 183) as comprising blue-black shales and flags with some developments of limestones, calcareous flags and bedded tuffs. A thickness of *c.* 1300 ft (396 m) was given and the contact with the underlying Betton Member described as gradational. Whittard's later lists (1966 : 299–307) of trilobites from the Shelve Inlier showed the trinucleids *Whittardaspis* [*Cryptolithus*] *inopinata* (Whittard) and *Lloydolithus lloydii* (Murchison), and the ogyginid *Ogygiocarella debuchii* (Brongniart), to be especially abundant and characteristic.

The boundaries of the Member as mapped by Whittard at various periods demonstrate changes of opinion but his final word on the subject (1966 : 298) defined the lithostratigraphic boundary with the overlying Rorrington Member as occurring at the point where 'bluish-grey shales with occasional thin, bluish limestones and sometimes bedded tuffs' (in which shelly faunas are abundant and graptolites rare except in a few thin bands) pass upwards into 'massive sooty-black graptolitic mudstones and shales', described as monotonously uniform. The change in fauna was said to be 'much more obvious than the lithological one', but there can be little doubt that one is dealing with a true lithostratigraphic boundary. The thickness of the Meadowtown Member as so interpreted was described by him as being much greater than he originally thought (i.e. in the early parts of the same monograph), and this was reflected also in the modified version of his field slips, on which the outcrop is considerably wider.

Although Meadowtown hamlet was given as type locality it is sited within the outcrop of the lowest third of the Meadowtown Member and for practical purposes the section there is confined to the vicinity of the classic but long-disused quarry, knowledge of which dates from the time of Murchison. The section in Meadowtown Quarry (Loc. 160) was measured by Whittard when it

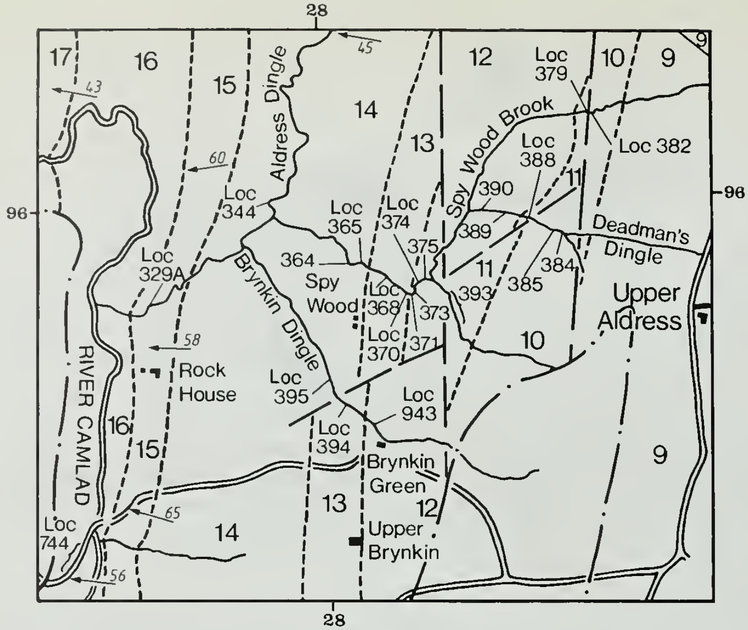

Fig. 30 Geological map of the faulted area around Spy Wood, NNE of Church Stoke. Overlaps Figs 23, 32. 9 = Weston Member; 10 = Betton Member; 11 = Meadowtown Member; 12 = Rorrington Member; 13 = Spy Wood Member; 14 = Aldress Member; 15 = Hagley Volcanic Member; 16 = Hagley Shale Member; 17 = Whittery Volcanic Member. (SO 29)

was reopened in 1932 and listed by him (1952 : 160). He noted that the *c*. 32 ft (9·75 m) of rock exposed could be divided into three parts:

3. Shales, 12 ft (3·66 m),
2. Mainly limestone, nearly 10 ft (3 m),
1. Flags, shales and limestones, nearly 10 ft (3 m).

To the east of the quarry and in the nearby roadway (Loc. 161) an underlying succession of flaggy, calcareous beds with bands of ashy material added a further 66 ft (20 m) of strata. West of the quarry and along the road leading towards Rorrington (Locs 164–6) successively higher levels were mapped. Near the point where the same road crosses Lower Wood Brook, a tributary of Desert Brook (Fig. 28, p. 42), and immediately NW along the stream, are exposures of blue-black mudstones (Loc. 144) with layers up to 3 in (76 mm) thick of small, black, nodular concretions about the size of a pea. These strata were originally mapped by Whittard as Rorrington Member but were later reinterpreted as Meadowtown Member. SE of the same road/stream junction, exposures throughout much of the Member are marked sporadically along Lower Wood Brook; the apparently lowest beds visible are marked at Loc. 504, where they comprise hard mudstones with massive bands of fine-grained tuffaceous material, and the lower boundary of the Member is drawn between this point and the nearby Loc. 505 which exposes blue-black, micaceous shales of the Betton Member.

The outcrop of the Meadowtown Member extends NNE from the eponymous hamlet as a broad strip that is 'stepped' westwards slightly at each of three small east–west faults, two of which coincide with dolerite intrusions, and ends beneath uncomformable Lower Silurian strata a short distance north of Betton Wood farm (Map). The northern half of this area is not well exposed but several outcrops are recorded in the vicinity of Mincop, and between there and Meadowtown.

SW of Meadowtown and beyond Lower Wood Brook, the Meadowtown Member extends SW to Holywell Brook at a point *c*. 1000 ft (305 m) SE of Rorrington, where the outcrop is shifted westwards on the south side of an arcuate, approximately ENE–WSW fault. The brook section SE of Rorrington (Fig. 25, p. 37) is of interest because, as a result of the faulting, one finds within the comparatively short distance of *c.* 450 ft (137 m) both Meadowtown/Rorrington and Betton/Meadowtown boundaries. The latter was not actually observed at the point where the mapped line is drawn (south of the arcuate fault), but the highest part of the Betton Member comprises the rocks at Loc. 437, described on p. 41. North of the fault, Loc. 431 marks the highest Meadowtown Member, and the adjacent section of Loc. 420 is assigned to the lowest part of the Rorrington Member.

The outcrop of the Member continues to the SW (Fig. 24, p. 36), so that shales and flags are exposed in the lane section (Loc. 470) near and SE of Middleton vicarage, to the south of which it narrows between two converging faults. The westerly of these is one of the large north–south tear faults which cut the Inlier, and to the west of it the outcrop of the Meadowtown Member appears narrower as the dips are steeper. At the top of the wooded area *c.* 1200 ft (366 m) NNW of Little Weston (Loc. 323) are small outcrops of usually tuffaceous shales and sandy, flaggy beds together with interbedded tuffs, some containing nodules, possibly calcareous (Fig. 29, p. 43). A short distance along the strike is the lane leading west from Little Weston, where Loc. 314 showed bluish-black shales with interbedded, thin, up to 3 in (76 mm) bands of limestone, decalcified marginally; the beds are almost vertical, but there is some hill creep. The outcrops of this area are truncated to the south by an east–west fault, to the south of which Meadowtown Member was shown in Whittard's original mapping, an interpretation subsequently modified to show a large outcrop of Rorrington Member underlying the feature of Spy Wood Member running along part of the upper reaches of Coed Brook (see p. 43).

Beyond the fault only two other outcrops of Meadowtown Member are encountered. The first, centred on the stream section about quarter of a mile (0·4 km) SW of Priestweston, is sub-rhombic in outline, divided into two unequal parts by the north–south tear fault noted above. In the eastern part, flags and sandy shales at Loc. 354 (Fig. 23, p. 34) yielded fragmentary fossils including *Ogygiocarella debuchii* and *Whittardaspis* sp. The western part is less well exposed but a small outcrop (Loc. 944) in a ditch, not noted in the earlier mapping, contained *O. debuchii* and *Lloydolithus lloydii*.

About half a mile (0·8 km) SSW and located between the same north–south tear fault and a subparallel fault sited a short distance to the west, is a small outcrop of Meadowtown Member centred *c.* 1500 ft (457 m) NW of Upper Aldress (Fig. 30, p. 44). The two halves of the outcrop are separated by one of the complementary shear faults associated with the tear faults. The northern half extends as a narrow strip between the stream sections of Deadman's Dingle (see description of Betton Member, p. 42) and the upper reaches of Spy Wood Brook. In the former section, Loc. 388 exposed dark, micaceous, blocky shales with numerous *O. debuchii*, rare *Primaspis* and inarticulate brachiopods; the rocks are faulted against those of the Betton Member, which may be seen a short distance upstream. The latter section (Loc. 379) exposes blue, fine-grained limestones and sandy shales with interbedded ashy bands which contain abundant pyrite and volcanic material mixed with argillaceous material; shale pellets and irregular, phosphatic nodular masses also occur. The southern half of the outcrop, triangular in outline, is cut by a small tributary stream which runs NW to Spy Wood Brook. The section (Loc. 393) shows rocks of the Rorrington Member at its NW end, cut by calcite veins and separated by a fault from dark-grey limestones and greenish-grey shales, both of which contain volcanic material, assigned to the Meadowtown Member. A few fossils are reported, including *O. debuchii*, inarticulate brachiopods and *Dicellograptus*. Immediately SE of the stream section, the Ordovician outcrops are terminated by glacial deposits forming the southern boundary of the Shelve Inlier.

Rorrington Member

First usage. As Rorrington Group by Lapworth (1887 : 662), a term subsequently modified to Rorrington Flags (Lapworth & Watts 1894 : 316, 318) and Rorrington Shales (Lapworth & Watts 1910 : 752) but with no apparent difference in meaning. A change to Rorrington Group or Stage, subdivided into successive Nemagraptus Beds and Leptograptus Beds (Lapworth 1916:

361; Watts 1925: 340) was abandoned by Whittard who (1931: 323, 332 and subsequent papers) preferred the term Rorrington Beds, corresponding to the present Member.

Type locality. Lower Wood Brook, near Rorrington (Whittard 1960 : 237).

Descriptive notes. The rocks were described as sooty, blue-black shales *c*. 1000 ft (305 m) thick by Whittard (1931 : 332; 1960 : 237) who assigned them to the *Nemagraptus gracilis* Zone and listed numerous species of graptolites and trilobites. As pointed out elsewhere (Dean *in* Williams *et al*. 1972 : 41), further refinement of the correlation between both Meadowtown and Rorrington Members and the corresponding graptolite zones must await description of the appropriate faunas.

In general, the outcrop of the Rorrington Member forms a broad band running SSW across the Inlier parallel to that of the Meadowtown Member. In an earlier version of Whittard's map the Rorrington outcrop was almost three times as broad as that of the Meadowtown Member, but following his later revision of the boundary between the two the outcrops were shown as of subequal breadth. The northernmost extension of the outcrop meets the superficial deposits forming the northern boundary of the Inlier in the vicinity of Lower Wood farm, where the beds are intruded by both dolerite dykes and a mass of dolerite (Map), and to a small extent are unconformably overlain by Lower Silurian strata. At the SW end of the quarry near Lower Wood farm the igneous rock, which was worked to a depth of 70 ft (21·3 m), is thrust over shales of the Rorrington Member. One small *Dicellograptus* ? and two minute ogyginid trilobites were found in the shales, of which a section (Fig. 28, p. 42) of 24 ft (7·3 m) was seen (Loc. 881), and the beds show no sign of metamorphism other than a hardening which might be due to mineralization along the contact rather than to heat. The igneous rock, which appears to be in the form of a boss, shows no chilled margin and on intrusion caused little induration of the shale.

The valley of Lower Wood Brook runs SSW from the eponymous farm for about three-quarters of a mile (1·2 km) and intermittent exposures of Rorrington Member appear. Unfortunately the stream runs approximately along the strike so that the exposures cover little more than a quarter of the total thickness. However, the valley of an unnamed tributary stream, which runs NW to join Lower Wood Brook a short distance upstream from the building named Desert, provides important information and may be regarded as a supplementary type locality as it shows several exposures in what is almost a dip section through the lower half of the Member (Fig. 28). Beds of the typical lithology were recorded at Loc. 516 though those at the eastern end were said to be a little more thickly bedded. *Ogygiocarella debuchii* was listed from the lowest fossiliferous strata there, and was recorded in association with *Marrolithoides arcuatus* Whittard slightly higher in the sequence. A short distance SSW along the strike, strata apparently at about the same horizon as the highest exposed at Loc. 516 were shown at Loc. 514, but containing a more varied fauna which included *Dicellograptus*, ostracods, inarticulate brachiopods and the trilobites *Primaspis whitei* Whittard and *Spirantyx calvarina* Whittard in addition to *O. debuchii*.

Slightly more than three-quarters of a mile (1·2 km) SSW, the valley of Holywell Brook also provides a dip section through the Rorrington Member, though it lacks exposures in the middle portion such as are found in Lower Wood Brook. On the other hand, it does show the lowest strata and, supplemented by the section in its tributary stream Grey Grass Dingle (Fig. 31), much of the highest part of the succession, though the boundary with the Spy Wood Member is obscured by a small fault. As noted earlier, Loc. 431 in Holywell Brook (Fig. 25, p. 37) exposes highest Meadowtown Member, with *O. debuchii*, *Cnemidopyge granulata* Whittard and ostracods. The closely-adjacent Loc. 420 shows shales with sandy shales or siltstones, and higher beds become progressively less resistant to weathering. Only inarticulate brachiopods were recorded there but the succeeding strata at Loc. 429 yielded *O. debuchii*, *C. granulata*, *S. calvarina* and *M. arcuatus*, while the rocks were said to include thin, up to 9 in (22·9 cm) bands of fine-grained tuffs in addition to shales of the usual type. The stream section continues as far as Loc. 427, but succeeding strata were seen only at Grey Grass Dingle, a short distance SW. Whittard's notes draw attention to the fact that these higher beds are poorly fossiliferous and speculate that the same may be true of all the higher beds of the Rorrington Member. Although fossils are so scarce

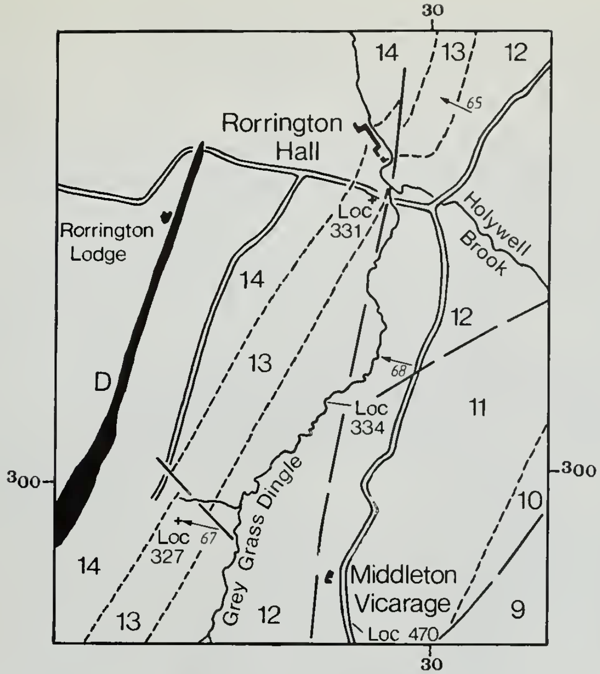

Fig. 31 Geological map of the area SW of Rorrington. Overlaps Figs 25, 28. 9 = Weston Member; 10 = Betton Member; 11 = Meadowtown Member; 12 = Rorrington Member; 13 = Spy Wood Member; 14 = Aldress Member; black outcrop D = dolerite. (SO 29, SO 39, SJ 20, SJ 30)

at Grey Grass Dingle, Loc. 334 is of interest as having yielded *Nemagraptus* in addition to *O. debuchii* and *M. arcuatus*.

The remaining outcrops of the Rorrington Member occupy a not inconsiderable area but, owing to the regressively-weathering nature of the rocks, reveal few exposures. In the area west of Little Weston, at and around the head-waters of Coed Brook, no exposures are documented on Whittard's maps and the outcrop is apparently delimited on the basis of the Spy Wood and Meadowtown Members, both of which are more clearly recognizable.

South of the ENE–WSW fault already noted near Little Weston, p. 45, the outcrop is shifted eastwards and its eastern boundary is faulted against the Weston Member of the Priestweston area. The mapped outcrop of the Rorrington Member is fairly extensive but, again, sections are few though a small tributary stream of Coed Brook shows exposures of rocks in the highest part of the Member *c.* 1850 ft (564 m) at 101° true from Hagley farm. From west to east there are good exposures at first of fine-grained, medium-grey, tuffaceous grit, followed by blue-hearted, rusty-weathering shale. Then, at Loc. 309, there are more massive beds traversed by numerous calcite veins. The shaly partings at this locality yielded *Marrolithus bilinearis* Whittard, a species generally found in the Spy Wood Member, and a single specimen of *Platycalymene duplicata* (Murchison) was recorded (Whittard 1960*a* : 156). Farther east in the same section, Loc. 310 exposed fossiliferous, blue-hearted, micaceous shale interbedded with bands of tuff up to 9 in (23 cm) thick; recorded fossils include rare *Spirantyx calvarina* and abundant ostracods, and some of the specimens were said to be preserved in pyrite.

About 1200 ft (366 m) NNE of Lower Aldress (Fig. 32) another east–west tributary of Coed Brook shows several exposures of shales together with some massive flags in the western part of the section, where the beds are faulted against the Aldress Member. Few fossils were found but *Leptograptus* and *Nemagraptus* were recorded at Loc. 351.

The southernmost exposures of this large, elongated outcrop occur in the faulted area of Spy

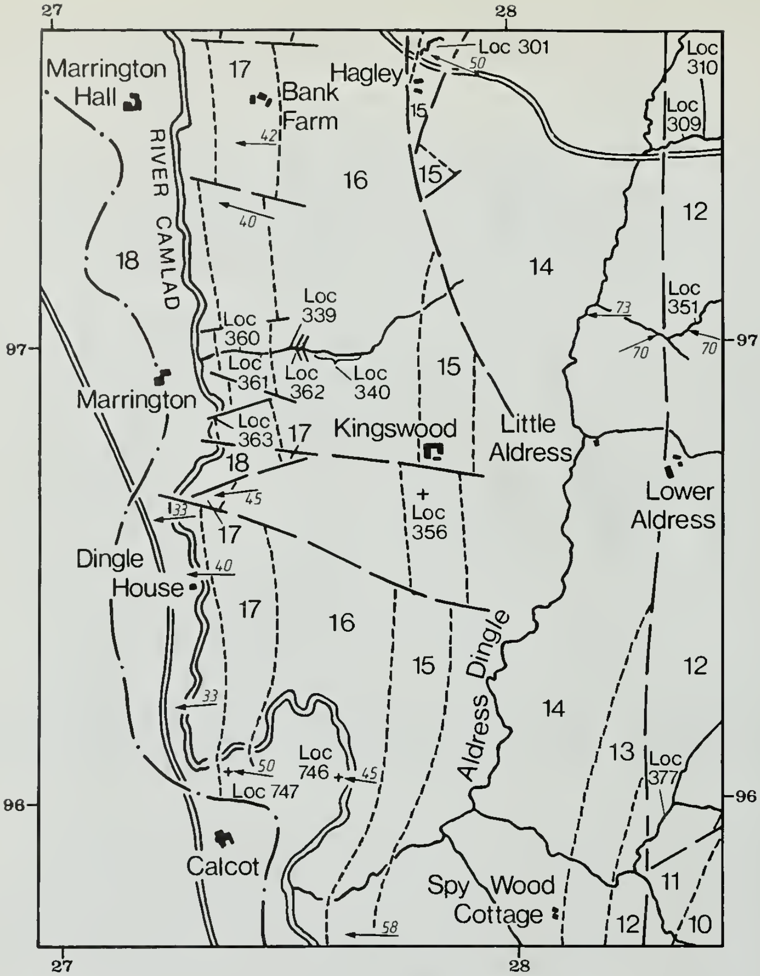

Fig. 32 Geological map of the area east of Marrington. Overlaps Figs 23, 30, 33. 10 = Betton Member; 11 = Meadowtown Member; 12 = Rorrington Member; 13 = Spy Wood Member; 14 = Aldress Member; 15 = Hagley Volcanic Member; 16 = Hagley Shale Member; 17 = Whittery Volcanic Member; 18 = Whittery Shale Member. (SO 29)

Wood Brook and part of its small tributary Deadman's Dingle, where a fairly continuous section in the lower half of the Member can be pieced together (Figs 30, p. 44, and 32). In the Spy wood Brook, rusty-weathering shales about the middle of the Rorrington Member occur at Loc. 377, where they yielded *S. calvarina* and *P. whitei*. The locality is just east of the fault separating the rocks from others forming the highest part of the same Member in which several localities, including 373–5, occur only a short distance below the base of the Spy Wood Member and contain a few fossils including *Marrolithoides arcuatus*. Higher upstream, and consequently lower in the succession, are poorly fossiliferous micaceous shales, weathering dark brown, underlain by nodular, greenish-grey siltstones. In Deadman's Dingle, rocks of the Meadowtown Member at Loc. 388 (see p. 45) are succeeded by shales of the Rorrington Member. Loc. 389, only slightly higher in the succession, proved poorly fossiliferous but yielded inarticulate brachiopods and a few graptolites (*Nemagraptus* ? and *Dicellograptus*) and was followed by beds of typical lithology at Loc. 390 containing *O. debuchii* and *S. calvarina*. Strata in the highest part of the Rorrington Member are seen also in Brynkin (= Bryncyn) Dingle, where *O. debuchii* and *S. calvarina* were recorded from shales at Loc. 943. These are the most southerly outcrops of the Rorrington Member, and only a short distance to the south and SE the rocks are overlain by glacial deposits.

Chirbury Formation

FIRST USAGE. As Chirbury Series (Lapworth 1887 : 662), the highest of three 'Series' of the Shelve Ordovician rocks and underlain by Meadowtown (later Middleton) Series. The term remained in constant use by both Lapworth and Watts until 1925 and was then abandoned without explanation.

TYPE LOCALITY. Presumably the area east of Chirbury village, but no type section was designated.

Spy Wood Member

FIRST USAGE. As Spy Wood Calcareous Grit, the lower of two subdivisions of the Aldress Group proposed by Lapworth (1887: 662). Later abbreviated to Spy Wood Grit by Lapworth & Watts (1894 : 316), the lower half of a newly-introduced Spy Wood Group (=Aldress Group of 1887).

TYPE LOCALITY. Spy Wood Brook (known alternatively as Spy Wood Dingle, Burn or Bourn), NNE of Church Stoke (Whittard 1960 : 253).

DESCRIPTIVE NOTES. Whittard (1931 : 332) described the rocks as flaggy, calcareous sandstones with interbedded greyish shales, weathering olive-green, which assumed a greater importance higher in the succession. The sandstones, when decalcified, were said to contain well-preserved fossils and there was an imperceptible passage upwards into the Aldress Shales (now Aldress Member). In a later paper (Whittard 1960 : 253) the thickness was given as 300 ft (91·4 m) and the strata were said to belong to the *Diplograptus multidens* Zone.

The southernmost extension of the Spy Wood Member is in the vicinity of Upper Brynkin and Brynkin Green (Fig. 30, p. 44), in which area it forms a feature that is covered to the south by glacial deposits forming the margin of the Shelve Inlier. To the north it is 'stepped' NE by two small faults which converge east and bound a small, triangular 'block', exposed (Loc. 394) in the small tributary stream of Coed Brook which runs NW from Brynkin Green and is shown in the manuscript notes, though not on the 6 in to 1 mile (1 : 10 560) O.S. map, as Brynkin Dingle.

More extensive exposures occur at several points in and near the stream which runs through Spy Wood and *c.* 450 ft (137 m) NE of Spy Wood Cottage (Fig. 30). Almost in the centre of the stream section is a good exposure (Loc. 368) of a small anticlinal fold pitching SW at 35°. The rocks in this vicinity are massive, highly micaceous, rusty-weathering flagstones, up to 1 ft (30 cm) thick, interbedded with sandy shales carrying globules of pyrite. Farther east along the same stream, the boundary of the Spy Wood Member and underlying Rorrington Member is exposed in the south bank (Loc. 370). Graptolitic strata of normal Rorrington lithology (Loc. 371) are followed by 9 ft (2·74 m) of micaceous, bluish-grey shale with interbedded thin bands of grey, micaceous, unfossiliferous flagstone. These are succeeded in turn by 12 ft (3·66 m) of more massive beds of typical Spy Wood lithology and it is at the base of these strata that the base of the Member is drawn. The sequence is apparently a normal one with no evidence of a basal conglomerate or angular discordance, and the presence of these unfossiliferous passage-beds at the top of the Rorrington Member was described briefly by Whittard (1952 : 163).

The western end of the same stream section demonstrates the transition between the Spy Wood and overlying Aldress Members. Although no continuous section is exposed the story, again, is one of gradual lithological change, with no evidence of a sharp lithological break at which to draw the boundary. Loc. 365 (Fig. 30) was considered by Whittard to be in the Aldress Member, and the boundary with the underlying Spy Wood Member was drawn at a point 52 ft (15·85 m) upstream (i.e. to the east). On this interpretation the upper beds of the Spy Wood Member comprise flagstones alternating with soft shales and flaggy, sandy shales, all showing various tones of grey and weathering to a dark, rusty colour which is characteristic also of the Aldress Member. The beds are much less massive than those in the lowest part of the Member, and the subdivision may be looked upon as forming the arenaceous base to the Aldress Member.

The Spy Wood Member is mapped as a feature NNE from Spy Wood Brook for *c.* 2000 ft (610 m), when it is truncated by a north–south tear fault running through Lower Aldress farm (Fig. 32, p. 48). It is not seen again until the vicinity of Lower Ridge farm, 1½ miles (2·4 km) east of Chirbury, where it reappears on the east side of the same north–south fault and forms a small, elongated outcrop along part of Coed Brook (Loc. 833 – Fig. 29, p. 43). A short distance north of Lower Ridge, a further subparallel outcrop recommences and continues NE intermittently to Rorrington Hall. There is little of note in this stretch, but the outcrop is 'stepped' by occasional faults of relatively small throw and (Fig. 31, p. 47) at Loc. 327, 2410 ft (735 m) at 045° true from Kinton farm, a mile (1·6 km) SW of Rorrington Hall, yielded two well-preserved brittle-stars in a bed less than 1·57 in (4 cm) thick within a succession that includes mainly sandy, micaceous, brown shales. At Loc. 331, 300 ft (91·4 m) south of Rorrington Hall and just inside the gate on the footpath to Kinton, beds low in the Member are exposed. They comprise micaceous, blue-black shales but, as the succession is ascended, sandy beds and flagstones appear alternating with the shales, some of which are sandy. It was here that an impersistent bed 1½ in (38 mm) thick yielded several starfish. Still higher in this dip section there is a progressive increase in sandstones until one reaches the typical so-called 'Beyrichia grits' of earlier authors, in which ostracods commonly occur in bands but are comparatively rare in the intervening strata. It was from this section that the type material of *Tetradella salopiensis* Harper (1947 : 351) was obtained.

The stream section immediately behind and NE of Rorrington Hall is not straightforward, owing to faulting, but probably represents the approximate thickness of the Spy Wood Member. None of the beds are true shales; all contain some sandy material, the more sandy ones pass into tough siltstones or fine-grained sandstones, and many are quartzitic in appearance. The SE end of the section would appear to indicate an upward passage from the Rorrington Member, with a progressive increase in flaggy beds. It is important to note that the rocks seem virtually unfossiliferous because they are not sufficiently weathered; when weathered, they may be richly fossiliferous in certain bands, and this condition was noted also in other sections, for example Spy Wood Brook.

From Rorrington Hall the outcrop of the Spy Wood Member extends (Fig. 28, p. 42) NNE, broken occasionally by small faults, to terminate at the northern boundary of the inlier about half a mile (0·8 km) west of Betton Wood Farm, where the rocks are overlain unconformably by Upper Llandovery strata which are themselves succeeded by Quaternary and Recent deposits. The beds form a mappable feature and débris rather than exposure tends to be the rule, but one outcrop (Loc. 415), 2900 ft (884 m) at 026° true from Rorrington Hall, is of particular interest as some of the rocks there (not those which are argillaceous or micaceous) yielded fossils which include the zonal trilobite *Costonia ultima* (Bancroft), indicating an age high in the Costonian Stage of the type Caradoc Series.

Aldress Member

First usage. As Aldress Graptolithic (*sic*) Shale, the upper of two subdivisions of the Aldress Group, by Lapworth (1887 : 662). No description was given and the term subsequently came into general use as Aldress Shale or, usually, Shales.

Type locality. Aldress Dingle, 1½ miles (2·4 km) NNE of Church Stoke, west Salop.

Descriptive notes. Brief accounts by Whittard (1931 : 333; 1960 : 32) described the rocks as grey or greenish-brown, soft shales with occasional bands of tuffaceous material in which the fossil assemblage is different from that found in the shales. The thickness was said to be *c.* 1000 ft (305 m), and the beds were assigned to the *Diplograptus multidens* Zone.

In the north of the Shelve Inlier, rocks of the Aldress Member underlie a strip of country, with a maximum width of some 0·7 mile (1·13 km) where affected by faulting but generally much less, which extends to a point half a mile (0·8 km) NE of Wilmington and is bounded to east and west by, respectively, the features of the Spy Wood and Hagley Volcanic Members. Striking physiographic features of this northern area are formed by elongated dolerite intrusions within the shale outcrop between Kinton and Rorrington Lodge, and to the east of Wilmington (Map), but the shales themselves are not well exposed.

The stream section running north almost along the strike from Rorrington towards Wilmington is excavated mainly in glacial deposits, but shows intermittent outcrops of shales and tuffs in the lowest third of the Member. A better section, in the highest strata and noted briefly by Whittard (1931 : 333), is that cut by the stream in Ox Wood (= Ox Wood Dingle), mid-way between Wotherton and Rorrington (Map), where several localities, some graptolitic, are marked on the manuscript map.

No notable sections are shown in the continuation of the overall outcrop SSW to the vicinity of Hagley, though small, scattered outcrops are found, particularly in stream sections. From Hagley southwards, however, there is an increase in the degree of availability of the rocks, particularly along the type section of Aldress Dingle (Fig. 32, p. 48), though the latter suffers from the disadvantage of being excavated almost along the strike and cuts mainly the middle and upper parts of the Member. Loc. 344 (Fig. 30, p. 44), 1750 ft (533 m) at 079° true from Calcot, is of interest as having provided the type material of *Dictyonema fluitans* Bulman (1928 : 35). Two dip sections along streams running east–west in the area immediately north of Lower Aldress farm show the lower beds of the Member, but the boundary with the underlying Spy Wood Member is seen satisfactorily only in Spy Wood Dingle, north of Spy Wood Cottage, noted on p. 49. The rocks in the lowest part of the Member here (Locs 364, 365) are medium-grey in colour but many comprise micaceous siltstones and flags rather than shales, and bedding planes are not always clearly developed (Fig. 30).

A further supplementary section is found in Brynkin Dingle, a term used by Whittard for a tributary of Aldress Dingle (Fig. 30). The lowest beds exposed (Loc. 395) are shales with grey, micaceous flagstones up to a foot (30·5 cm) thick, below which is a thin, inch (2·5 cm) band of white, shaly material, possibly a bentonite and perhaps one of the occurrences noted for the Aldress Member by Whittard (1952 : 164). Shales with flags in the highest part of the Aldress Member were noted in Aldress Dingle only a short distance upstream from the mapped base of the Hagley Volcanic Member, but no detailed account of the boundary was given. From Aldress Dingle to the southern margin of the Inlier, the only outcrops of Aldress Member shown on the manuscript map are some exposures of shale along the stream section which runs westwards to join the Camlad about 500 ft (152 m) NE of Alport. The outcrop was not numbered and no notes were made.

Hagley Volcanic Member

First usage. As 'Hagley volcanic ashes and shales' (Lapworth 1887 : 662), a term equivalent to the present Hagley Volcanic Member and Shale Member combined. 'Hagley Ash' was separated by Lapworth & Watts (1894 : 316, 318) and later passed into general use as the Hagley Volcanic Group (Whittard 1931 : 323), equivalent to the present Member.

Type locality. Hagley Quarry, near Chirbury (Whittard 1960 : 145).

Descriptive notes. In a brief note on the subdivision Whittard (1931 : 333) stated: 'This contains massive crystal and lithic tuffs, which are often brecciated and agglomeratic. The normal rock is of a pale greenish colour, brindled with darker green rings'. Later (Whittard 1952 : 164) he gave a thickness of 350 ft (106·7 m) and noted that at Hagley Quarry graptolitic evidence of the *clingani–linearis* Zones had been found. The latter interpretation has now been superseded and the Member is known to belong to the Lower Soudleyan Stage of the Caradoc Series, equated with part of the *Diplograptus multidens* Zone.

The northernmost limit of outcrop is in the area between Wotherton and Wilmington, where volcanics form a wide feature at Big Cuckoo Nest and Little Cuckoo Nest, just west of Ox Wood Dingle (Map and Fig. 34). The strip-like outcrop here runs SSW through the eastern half of Crest Wood, displaced by small east–west faults, but owing to strike faulting it becomes markedly narrower towards the south end of the wood where it is truncated by a prominent north–south tear fault which displaces the outcrop dextrally. On the west side of this fault the outcrop is shifted NW as far as Rockabank farm and from there to the south forms a feature which extends to Hagley farm (Figs 33–34).

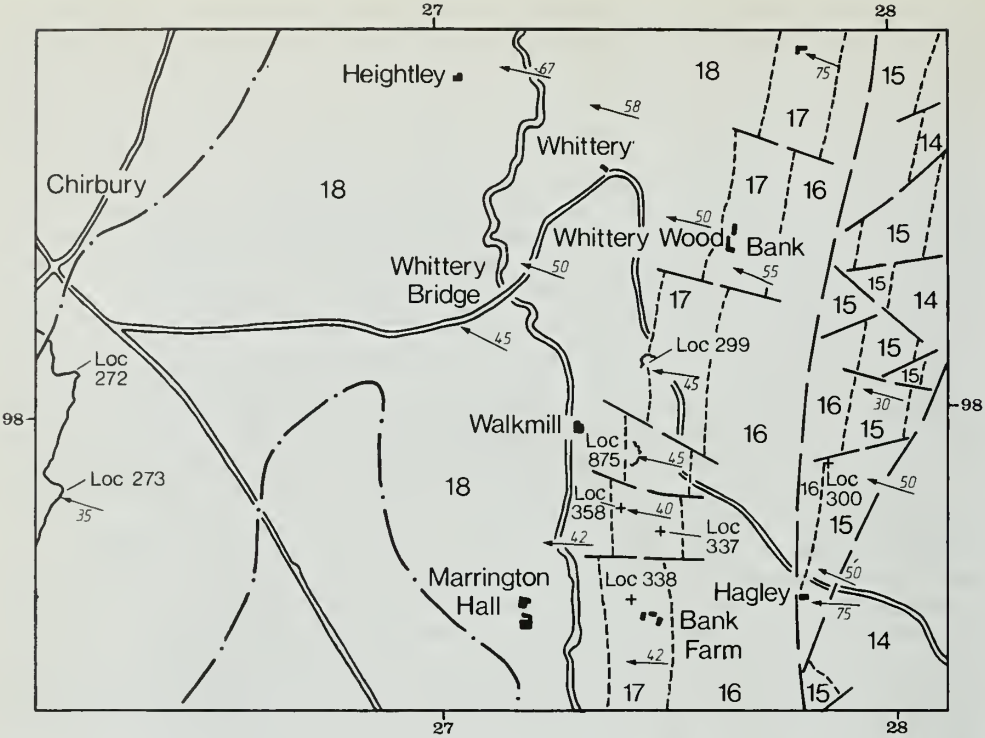

Fig. 33 Geological map of the Whittery area, east of Chirbury. Overlaps Fig. 32. 14=Aldress Member; 15=Hagley Volcanic Member; 16=Hagley Shale Member; 17=Whittery Volcanic Member; 18=Whittery Shale Member. (SO 29)

Hagley Quarry (Loc. 301), the type locality, lies just north of Hagley farm and by the side of the Chirbury–Priestweston road. The area is poorly exposed and although the map shows the upper boundary of the Volcanic Member almost coincident with the western margin of the roadside quarry, the stratigraphical base is not visible here owing to a fault which runs from Upper Ridge farm to Hagley farm and intersects the strike at an acute angle. Hagley Quarry is of particular interest for having yielded graptolites, which were collected from water-deposited tuffs by members of the Geological Survey. The fauna, listed by Whittard (1931 : 333–334), was originally quoted as indicating the topmost *clingani* or basal *linearis* Zone, a widely-quoted but mistaken interpretation that has since been modified to *multidens* Zone (see above). At a point 1000 ft (305 m) just east of north from Hagley farm, and on the western edge of the same volcanic feature, are the remains of an old adit (Fig. 33) from which, according to Whittard's notes, both barytes and (at depth) galena were at one time obtained (Loc. 300).

Apart from a small break just south of Hagley, the feature of volcanic rocks extends southwards to Church Stoke village. Tuffs and agglomerates are seen at Kingswood farm (Fig. 32, p. 48), and an old quarry (Loc. 356) 300 ft (91·5 m) south of the building shows a good exposure in greyish-yellow weathering, lithic tuff with interbedded agglomerate. 'Throstle-breasted' and other types of tuff crop out (Loc. 382A) 3200 ft (975 m) at 190° true from Kingswood (Fig. 32, p. 48), near the ford in Aldress Dingle and a short distance from the River Camlad, but otherwise there is little of note until one reaches the roadside quarry (Loc. 399) 450 ft (137 m) north of Church Stoke Hall. At this point tuffs, interbedded with shales and showing false ripple-marking, yielded the trinucleid trilobites *Broeggerolithus* cf. *broeggeri* (Bancroft) and *Salterolithus caractaci* (Murchison), indicating a Lower Soudleyan age within the Caradoc Series. Intermittent outcrops of tuffs continue south for *c.* 1500 ft (457 m) before disappearing beneath glacial deposits (Fig. 35, p. 55).

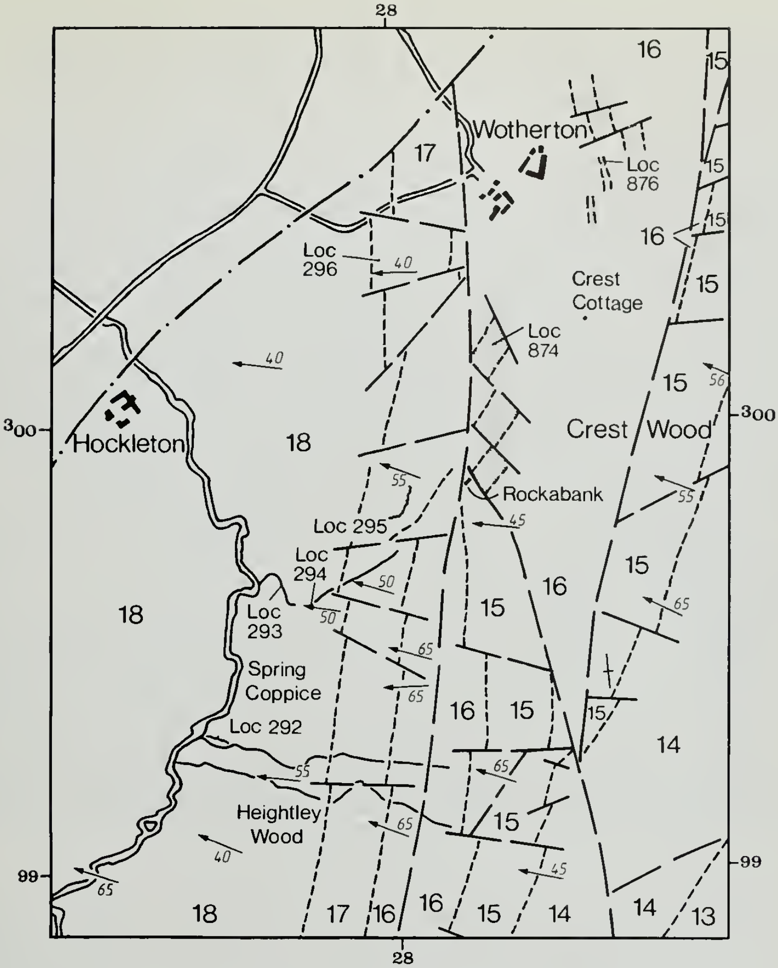

Fig. 34 Geological map of the area south of Wotherton and NE of Chirbury. Adjoins Fig. 29. 13 = Spy Wood Member; 14 = Aldress Member; 15 = Hagley Volcanic Member; 16 = Hagley Shale Member, including tuff beds (dotted); 17 = Whittery Volcanic Member; 18 = Whittery Shale Member. (SO 29, SJ 20)

Hagley Shale Member

First usage. As Hagley Shales by Lapworth & Watts (1894 : 340, 342), a term which has since remained in almost constant use.

Type locality. No specific section was designated, though the general vicinity of Hagley farm, a mile (1·6 km) SE of Chirbury was presumably intended. The subject is discussed in more detail below.

Descriptive notes. Whittard (1931 : 333; 1960 : 144) described the strata briefly as 'rusty-weathering, bluish shales, with harder olive-green shales tending to be nodular'. At that time they had not yielded fossils but a few have now been found (see p. 54). The thickness was said to be of the order of 1000 ft (305 m).

Much of the neighbourhood of Wotherton village (Map and Fig. 34) is underlain by rocks of the Member but whereas outcrops of shales and flagstones are rare here, bands of tuffs and agglomerates within the shales are more resistant and, consequently, available for examination.

In particular a thin band of coarse agglomerate was seen in the sides of the road (Loc. 876) leading to Rorrington, *c.* 600 ft (183 m) ENE of Wotherton. About 1200 ft (366 m) south of Wotherton (Loc. 874) are exposures of volcanics which are unusual in that the surfaces show what appears to be flow banding; if this is correctly interpreted, then we are dealing with one of the few lavas known from the area.

At Loc. 340 in the stream-section 1250 ft (381 m) at 084° true from Marrington farm (Fig. 32, p. 48) nearly all the succession, apart from one short length covered by felled trees, is visible. Whittard's notes did not specify this as type section for the Member, but it might be used as at least a supplementary type section. The rocks comprise bluish-grey hearted, greenish-grey weathering shales which on the outside are altered to a yellowish brown. Some are soft and contain little mica. Interbedded with the shales, and dominant in the lower part of the succession, are greenish-grey weathering, flaggy micaceous siltstones; less commonly there are more arenaceous, light grey flags. A striking feature of all these rocks is the general paucity of fossil remains, and the most abundant specimens so far found are from interbedded tuffs. In most respects the rocks of the Hagley Shale Member are comparable with those of the Whittery Shale Member and clearly belong to the same deposition, the Hagley and Whittery Volcanic Members representing short-lived episodes of vulcanicity which nevertheless resulted in a considerable thickness of deposits. The more westerly outcrops (Loc. 339) of the Shale Member in this stream section are deeply-weathered, friable shales in which amplexoid-like graptolites have been found. Between these rocks and the main section is a large bed of tuff (Loc. 362) *c.* 7 ft (2·13 m) thick, with some interbedded shales.

Further exposures of the Hagley Shale Member are seen in the vicinity of the River Camlad both NE and SE of Calcot (Fig. 32, p. 48). At Loc. 746 a presumably interbedded tuff shows occasional graptolites in relief and contains the trinucleid trilobites *Broeggerolithus broeggeri* (Bancroft) and *Salterolithus caractaci* (Murchison), indicating a Caradoc, Lower Soudleyan age. A good section in the lane immediately NE of Alport (Loc. 744) shows 130 ft (39·6 m) of shales (Fig. 30, p. 44) with flagstone beds dipping approximately 50° at 290° true. Nearly 30 bands of flags occur, ranging from an inch (2·5 cm) to a foot (30 cm) in thickness and totalling some 6 ft (1·83 m). A small shelly fauna again indicates a Lower Soudleyan age. Whittard's notes suggest that the section might well be ranked as a type section for the Member.

Shales of the Member crop out intermittently along the Chirbury road just outside the village of Church Stoke (Fig. 35), particularly at Loc. 742, 1550 ft (472·4 m) north of St Nicholas' church. The exposure there includes several beds, up to 2 in (5 cm) thick, of tuffaceous flags, horizons which suggest that the volcanics of the succeeding Member are being anticipated. Within Church Stoke village, the road section 500 ft (152·4 m) at 323° true from St Nicholas' church (Loc. 739) shows rusty-weathering, greenish-grey, micaceous shales with thin, seldom more than 2 in (5 cm) bands of micaceous flags, beds which yielded *B. broeggeri* and *S. caractaci.* Loc. 738, 400 ft (122 m) at 212° true from St Nicolas' church, shows greenish-grey, micaceous flags and shales which constitute the last exposure of the Hagley Shale Member before glacial deposits forming the southern boundary of the Inlier are reached.

Whittery Volcanic Member

First usage. As Whittery Ashes, by Lapworth (1887 : 662). The name was listed in a stratigraphical table and no further details were given.

Type section. According to Whittard (1960 : 283) it is 'quarry in Marrington Dingle, east of Whittery, west Shropshire'. This appears to be a misprint because no such quarry exists east of the farm named Whittery, and Marrington Dingle lies to the south of both Whittery and Whittery Wood. It seems likely that the intended type section was the one in Whittery Quarry, just over a quarter of a mile (0·4 km) SSE of Whittery and at the southern end of Whittery Wood. There only the upper portion of the volcanic member is exposed, together with the basal part of the succeeding Whittery Shale Member (see p. 59).

Descriptive notes. Published descriptions of the Whittery volcanic rocks are both few and brief. Lapworth's introduction of the term in 1887 gave no description. Lapworth & Watts (1894 : 316,

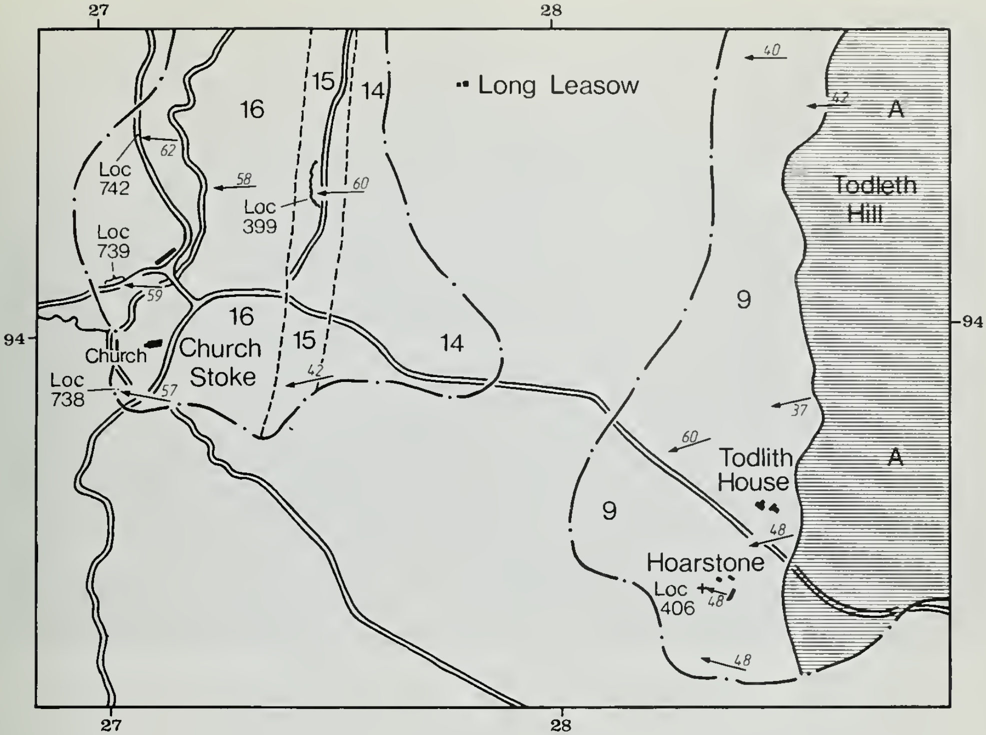

Fig. 35 Geological map of the area between Church Stoke and Todleth Hill, in the SW corner of the Shelve Inlier. 9 = Weston Member; 14 = Aldress Member; 15 = Hagley Volcanic Member; 16 = Hagley Shale Member; horizontally shaded outcrop A = andestic intrusion of Todleth Hill. (SO 29)

318–319) noted the rocks as 'Whittery Ash' and listed them in a stratigraphical table. They cited Whittery Quarry and Walk Mill Quarry (presumably the quarry *c.* 450 ft (137 m) SE of Walkmill; Fig. 33, p. 52) as being places where the beds were 'splendidly exposed'. The volcanics were said to consist of 'andesitic and rhyolitic breccias and conglomerates, fine ashes with curious spherulitic or pisolitic structures, and bands of shale often fossiliferous'. Beds showing ripple markings were also recorded.

Whittard (1931 : 333) stated merely 'The Whittery Volcanic Group repeats the general lithological and petrological characters shown by the rocks of the Hagley Volcanic Group'; later (1952 : 164) he noted the rocks only briefly and gave the thickness as 300 ft (91·5 m). Subsequently (1960 : 283) he described them briefly as 'crystal and lithic tuffs, agglomerates and breccias with thin interbedded shales. Thickness 300 ft.'

The northernmost outcrops of the Whittery Volcanic Member occur in the vicinity of Wotherton (Fig. 34, p. 53), where part of the outcrop is faulted against the Hagley Shale Member to the east and the beds, which dip 40° bearing 280° true, were once quarried at Rock Coppice (Loc. 296). The nature of the junction between the Whittery Volcanic and Shale Members at this locality is noted in more detail under the description of the latter Member.

Of particular interest in this district is the outcrop 500 ft (152 m) SW of the house called Rockabank, 2250 ft (686 m) south of Wotherton (Fig. 34). At this point (Loc. 295) there occurs what Whittard described as an 'amazing development' of volcanic agglomerate with boulders up to 3 ft (0·9 m) in diameter, though most are half that size or smaller, in a matrix of coarse lithic tuff (Fig. 37). Those blocks which were examined showed the rock to be a lava, possibly a hornblende andesite, and the boulders are so numerous, and in places so tightly packed together,

Fig. 36 Topography of ridges formed by Whittery Volcanic Member, here faulted, with intervening hollows excavated in regressive, interbedded shales. View looking south from Rockabank, 600 yd (550 m) south of Wotherton, towards Heightley Barn, 600 yd (550 m) NE of Whittery.

that the matrix is not easy to find. There is no evidence, either north or south of the Rockabank outcrop, of volcanic material which approaches this agglomerate in coarseness, though good outcrops of agglomerate showing fragments up to 3–4 in (75–100 mm) occur nearby. The question remains: have we at last a focus for part of the Caradoc vulcanicity in the Shelve Inlier? Mapping fails to show that the rock is in the form of a neck, although the general shape of the outcrop tends to suggest this. On the other hand, the rock appears to be interbedded; but here one should remember that, assuming the neck was originally vertical, the sides of the neck would now be approximately at 45°.

The volcanic rocks of the Whittery Volcanic Member in this area form a feature which runs SSW, its position 'stepped' by intermittent dip faults, but occasional indentations run along the strike owing to differential erosion of shale beds in the sequence, and it is clear that not inconsiderable masses of shale occur interbedded in the marine volcanics. On a hillside such as the east side of Marrington Dingle (Fig. 32, p. 48), where the top and bottom of the Volcanic Member can be mapped with reasonable confidence, shale fragments have been brought to the surface by rabbits at several points mid-way up the slope. A shale depression was mapped north of Heightley New Barn, 1650 ft (503 m) NE of Whittery, and may represent a similar condition appearing farther south (Fig. 33, p. 52).

The large quarry (Loc. 299) at the southern end of Whittery Wood (Fig. 33) is the original Whittery Quarry and therefore the probable type section for the Volcanic Member, the rocks of which were once extensively quarried there. The section shows also part of the overlying Whittery Shale Member, the beds of which include flags and bands of volcanic rocks, indicating waning vulcanicity as at Loc. 296 (see p. 59). Some of the bands may be up to 2 ft (0·61 m) thick and one may once more appreciate the possibility of misidentifying such rocks as part of the Volcanic Member when seen in isolated exposures. Six hundred feet (183 m) to the south is a smaller quarry (Loc. 875), almost certainly the Walk Mill Quarry of Lapworth & Watts (1894 : 318), which shows

Fig. 37 Volcanic agglomerate in Whittery Volcanic Member at Rockabank, 600 yd (550 m) south of Wotherton, 1·9 miles (3 km) NE of Chirbury.

normal volcanics but is of interest because at the top there is a band showing flow-casting on its lower surface, where it rests on shale.

Four hundred feet (122 m) south of Walk Mill Quarry a variety of tuffs, both lithic and the so-called 'throstle-breasted', is shown (Fig. 33, p. 52) in a small disused quarry (Loc. 358), 300 ft (91·4 m) SE of which is a hillock where good exposures (Loc. 337) of agglomeratic tuff are found, with well-rounded boulders, some attaining a length of a foot (30 cm). Northwards the agglomeratic character of the rock remains evident but the agglomerate is obviously interbedded with crystal and lithic tuffs. The hillock is peculiar in that it is followed to the west by a flat region before the steep flank of Marrington Dingle is reached, and it is not clear whether one is dealing with an isolated outcrop or one that is faulted from the main outcrop of Volcanic Member. The hillock is separated by a small valley from the outcrop of Volcanic Member as traced from the north and it strikes southwards into open country.

Good examples of agglomerate occur a little farther south on another hillock (Loc. 338) upon which Bank Farm, 900 ft (274 m) east of Marrington Hall (Fig. 33) is built. This should not be confused with the building called Bank which is situated 1060 ft (323 m) SE of Whittery (Fig. 33).

The faulting of the Whittery Volcanic Member in the area parallel to Marrington Dingle and south of Whittery Wood is noteworthy because, by the usual methods of determination, the downthrow is to the north. However, if the upper surface of the volcanics is traced in relation to its O.D. level, the fault block to the south is at a lower level than its fellow to the north, so that the downthrow is apparently to the south. It would appear that the south side is really the downthrow, but that tear-faulting has resulted in a greater horizontal than vertical movement. Consequently the horizontal shift (to the east on the north side of each fault) is greater than the displacement due to a southerly downthrow.

At a point 210 ft (64 m) ENE of the building called Marrington (Fig. 32, p. 48), the east bank of the River Camlad is intersected almost at right angles by an unnamed stream,the upper reaches of which show an almost continuous section (Locs 360–1) through the Whittery Volcanic Member.

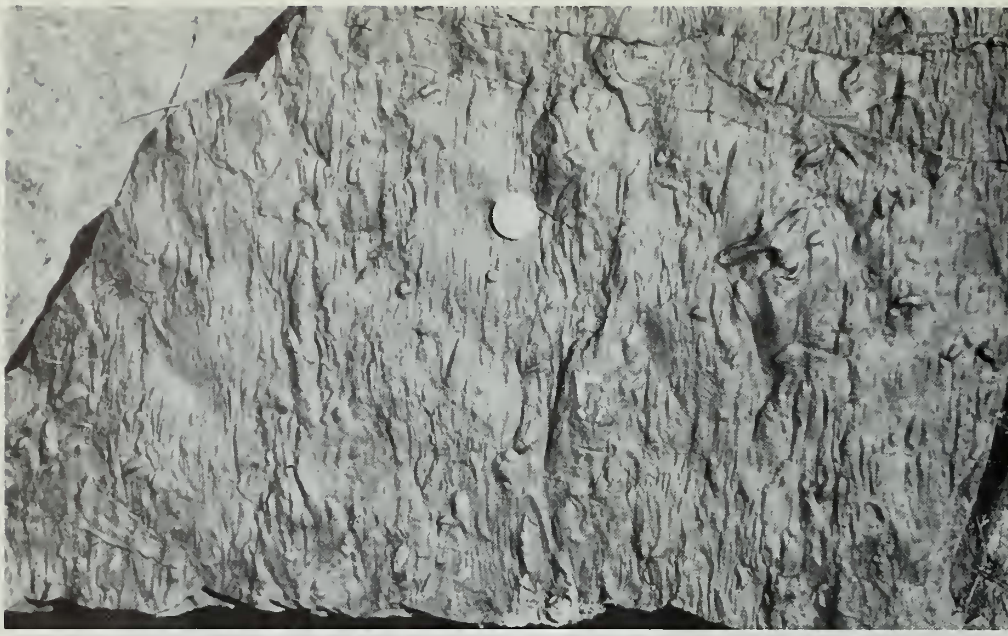

Fig. 38 Flow casts in Whittery Volcanic Member. Quarry 220 yd (200 m) south of Whittery Quarry, 0·83 mile (1·34 km) east of Chirbury. (Coin 28 mm diam.)

The stratigraphically lower half of the sequence (Loc. 361) contains much more shale than the higher half and the tuffaceous rocks are much finer grained, some of them yielding graptolites. At this point volcanics seen just above a bed of shale 1½ ft (46 cm) thick occur in large, concretionary masses which are pillow-shaped, concentrically banded and a minimum of 4 ft (1·22 m) in diameter. These are demonstrably depositional and not tectonic structures. Some anomalous easterly dips seen a little farther upstream may indicate strike faulting and folding, thought to be of a very minor character.

Farther SW, 440 ft (134 m) SE of Marrington, a section (Loc. 363) in the Camlad shows a slight anticlinal flexure whereby volcanics near the top of the Member occur in the river and are succeeded by beds of the Whittery Shale Member, seen in the west bank only a short distance south.

The southernmost outcrops of the Whittery Volcanic Member are seen at an old quarry (Loc. 747; Fig. 32, p. 48) just north of Calcot and by the west bank of the Camlad. A minor syncline is developed there and the rocks, which include tuffs interbedded with shales at the eastern end of the quarry, are much broken. Southwards beyond this point the outcrops are obscured by glacial deposits.

Whittery Shale Member

First usage. By Lapworth & Watts (1894 : 316, 319). The name was listed as Whittery Shale in a stratigraphical table and as Whittery Shales in the text, but no description was given.

Type locality. None was designated by Lapworth & Watts, though the beds were said to 'form the ground between Marrington and Chirbury'. The base of the Member is seen at Whittery Quarry (see p. 56).

Descriptive notes. The rocks of the Whittery Shale Member resemble those of the Hagley Shale Member, and comprise predominantly blue-grey, micaceous shales which appear light rusty brown or olive-green after weathering. Other, but subsidiary, rock-types include bluish green, heavily micaceous, flaggy bands and both fine- and coarse-grained interbedded tuffs. The tuffs in particular are liable to be found fossiliferous, with both shelly and graptolitic faunas.

Whittery Quarry (Loc. 299), at the southern end of Whittery Wood, near Chirbury (Fig. 33, p. 52), exhibits the boundary of the Whittery Shale Member with the underlying Whittery Volcanic Member. The rocks there dip 45° bearing 292° true and show flags and volcanic bands interbedded with the shales. One important feature there is that within the shales there may be bands of volcanics up to 2 ft (0·61 m) thick, and small, isolated exposures of such rocks might lead one to map such outcrops mistakenly as the Whittery Volcanic Member.

The junction between the Volcanic and Shale Members is seen also in the western part of the old quarry (Loc. 296) at Rock Coppice, 333 yd (305 m) SW of Wotherton (Fig. 34). Above the massive tuff there are alternations of thin tuff, mostly 1 in (25 mm) but at maximum 2 in (51 mm) thick, and shales up to 6 in (152 mm) thick, totalling about 6 ft (1·83 m), after which point normal shale conditions became established. The junction between the two members is thus a normal one, with a gradual passage from volcanics to shale, demonstrating that the end of the vulcanicity was marked by a few, probably explosive, eruptions. This was the last of the vulcanicity in the Ordovician of west Salop except for tuffaceous bands at several levels in the Whittery Shale Member, indicating short and unimportant recrudescences in the vulcanicity.

Streams flowing westwards into the River Camlad and down the dip of the Whittery Shale Member show almost continuous sections at points 2600 ft (792 m) NE (Loc. 292) and *c.* 3800 ft (1158 m) NNE (Loc. 293) of Heightley (Figs 33–34), near Chirbury. The predominant rock type is shale but bands of flagstone are developed; a peculiar and so far characteristic rock is a tuffaceous shale which contains stony fragments up to half an inch (13 mm) in diameter. The latter rock type occurs also at Loc. 294, *c.* 250 ft (76 m) SE of, and upstream from, Loc. 293, and has yielded fossils which include *Salterolithus caractaci* (Murchison) and *Broeggerolithus broeggeri* (Bancroft), characteristic of the Glenburrell Beds (Lower Soudleyan) of the Onny Valley in SE Salop.

Beds high in the Shale Member crop out along the stream south of Chirbury at Locs 272 and, especially, 273 (Fig. 33, p. 52). The latter shows a good section in which shale is the predominant element though there are some flaggy layers. A few graptolites have been obtained from this locality.

The most westerly exposure of the Ordovician rocks of the Shelve Inlier occurs at Loc. 752, a quarter of a mile (0·4 km) NE of Trimberth. Thirty years ago the strata of the Whittery Shale Member were better exposed there than nowadays but the lithology is typical and there is no mistaking their age. Of passing interest there is a small quarry where the shales are no longer exposed but could be examined thirty years ago; on that occasion the dip was found to be high and to the SE. The significance of this change-round from a prevailing westerly dip cannot be determined as there are no other exposures in the immediate neighbourhood, where the only material to be seen is the ubiquitous boulder-clay.

Miscellaneous notes

Correlation with neighbouring Ordovician successions

The correlation of the Shelve Ordovician rocks with those of the Caradoc District, the Breidden Hills and the Pontesford district was summarized by Whittard (1952 : table III) in a table which listed the corresponding graptolite zones. The Stiperstones Member and Mytton Member were equated with the combined *Didymograptus extensus* and *D. hirundo* Zones; the Hope, Stapeley Volcanic, Stapeley Shale and Weston Members with the *D. bifidus* Zone; the Betton Member with the *D. murchisoni* Zone; and the Meadowtown Member questionably with the *Glyptograptus teretiusculus* Zone. The Rorrington Member was equated with the *Nemagraptus gracilis* Zone and part of the *Diplograptus multidens* Zone; the Spy Wood Member questionably with part of the *D. multidens* Zone; and the Aldress Member with part of the *D. multidens* Zone and part of the *Dicranograptus clingani* Zone; the remainder of the succession was equated with part of the *D. clingani* Zone and the *Pleurograptus linearis* Zone.

The problem of how to account for this supposed correlation of the highest Ordovician strata of the Shelve Inlier troubled Whittard for several years and appears to have arisen from the Geological Survey's discovery of graptolites in tuffs of the Hagley Volcanic Member at the type locality of Hagley Quarry. This find was reported by Whittard (1931 : 334) and the specimens, identified by G. L. Elles, were interpreted as indicating 'a horizon about the base of the Zone of *Pleurograptus linearis* or at the very top of the Zone of *Dicranograptus clingani*'. However, it had for some years been customary to regard the Shelve Ordovician rocks as constituting a virtually complete succession. For example, Watts (1925 : 340, 343) placed the top of the Caradoc Series immediately above the Whittery Volcanic Member and regarded the Whittery Shale Member as possibly representing the Ashgill. Consequently no major policy change was required in order to relegate the Whittery Shale Member to a slightly lower horizon, supposedly in the highest Caradoc Series.

Correlation of the Shelve rocks of Caradoc age has been facilitated by use of the 'shelly' zones and stages established by B. B. Bancroft, though their original application was often inaccurate and only relatively recently has a more convincing picture emerged. Bancroft's (1933) correlation tables followed the previous practice (e.g. Lapworth & Watts 1894 : 316) of equating the Hoar Edge Grits of the Caradoc district with the Spy Wood Member (then Spy Wood Grit), claiming that the latter contained '*Marrolithus* (Costonian type)'. Whittard's (1966 : 281) later discovery of the South Salop Costonian index trilobite *Costonia ultima* (Bancroft) – a species originally assigned to *Marrolithus* – in the Spy Wood Member (see p. 50) showed this part of Bancroft's table to be essentially correct, though it had probably been made for the wrong reasons, as Bancroft never recorded any South Salopian species from the Shelve Costonian and his collection contained no such material. Bancroft did record a trinucleid assemblage of *Broeggerolithus broeggeri* (Bancroft) and *Salterolithus* from the Hagley Shale Member as being indicative of the Soudleyan Stage, to which subdivision he also assigned the Whittery Volcanic Member, but the remainder of his succession showed the Whittery Shale Member ranging in age from Soudleyan to Onnian and he did not recognize that most of the Caradoc Series is missing from the Shelve Inlier.

Some of Whittard's 1952 conclusions were subsequently revised by him and in the first part of the Shelve trilobite monograph (Whittard 1955 : 5) the Whittery Volcanic and Shale Members were said to extend no higher than the *D. multidens* Zone and, questionably, the basal *D. clingani* Zone, a conclusion more in keeping with evidence from the Caradoc Series of the type area. In a later part of the monograph (Whittard 1966 : 297) both the Betton Member and the underlying Weston Member were placed in the *D. murchisoni* Zone, thus reverting to a correlation suggested much earlier (Whittard 1931 : 331).

Correlation of the shelly and graptolitic faunas in the Llandeilo and lowest Caradoc Series proved difficult and Whittard's (1966 : 298) final published pronouncement differed from his earlier interpretations, particularly with reference to the boundary between the Meadowtown and Rorrington Members and the stratigraphic value of such trilobites as *Lloydolithus lloydii* (Murchison). The latter was shown to be confined to the Meadowtown Series which, in turn, had previously been equated with the whole of the Llandeilo Series and the *Glyptograptus teretiusculus* Zone. More recent work on the Ordovician of south Wales by Addison (*in* Williams *et al.* 1972 : 35–36) clarified the situation by showing that the Meadowtown Member, with its abundant and characteritic *L. lloydii*, corresponds only to the Lower Llandeilo of the type area, and demonstrated that the base of the *Nemagraptus gracilis* Zone must be extended downwards to include, at least approximately, the Middle and Upper Llandeilo Series. We may note here that a revision (Dean 1967: 317–319) of the correlation between the Caradoc stages and corresponding graptolite zones placed the highest Costonian of the Caradoc in the *D. multidens* Zone by analogy with the Shelve succession, while the underlying Costonian strata contain a shale band yielding *Nemagraptus gracilis*. At Shelve the Spy Wood Member, at least partly Costonian in age, is underlain by shales of the Rorrington Member, a subdivision said by Whittard (1955 : 5) to include both the *N. gracilis* and *D. multidens* (in part) Zones, so that correlation of shelly and graptolitic faunas in this part of the succession is not yet precisely defined.

The Ordovician rocks of the Breidden Hills, *c.* 9 miles (14·5 km) NNW of Shelve, were described by Watts (1925 : 340, 343) and later by Wedd (1932), who erected a number of local lithostratigraphic names, some of which may represent strata duplicated by faulting. The relatively restricted succession commences with a series of 'Lower Shales', base not seen but thickness at least 1770 ft (540 m), which are known also as Nemagraptus Shales as they contain the eponymous genus and other graptolites suggesting an assignment to the *N. gracilis* Zone, and thus to the lowermost Caradoc or Middle/Upper Llandeilo Series. The shales are succeeded by the so-called 'Black Grit', a flaggy, black sandstone 20 ft (6 m) thick which corresponds in position approximately to the Spy Wood Member of Shelve and part of the Hoar Edge Grits of the Caradoc district. The sandstone is followed by a sequence 1870 ft (570 m) thick comprising flags and shales with two groups of volcanic rocks, which proved partially fossiliferous and from which Standring (Dean *in* Williams *et al.* 1972: 41) obtained the Lower Soudleyan trilobites *Broeggerolithus broeggeri* and *Salterolithus caractaci*. This record confirms to a large degree Watts' (1925 : 343–344) correlation of the Breidden volcanics with the Hagley and Whittery rocks of Shelve, though Whittard (1952 : table 3) at one time regarded them as being somewhat older.

Only three-quarters of a mile (1·2 km) east of the north end of the Shelve Inlier lies the small, isolated area of Ordovician rocks beside the eastern flank of Pontesford Hill (Map). Redescribed by Dean & Dineley (1961), these are known now to include a basal conglomerate which rests with marked unconformity on Pre-Cambrian (Uriconian) rocks and is followed successively by grey shales with *Diplograptus multidens* and then grey-green mudstones containing both graptolites of the *D. multidens* Zone and trilobites of the Lower Soudleyan Stage. These last two sets of strata correspond respectively to the Harnage Shales *sensu stricto* of the northern Caradoc district and the Glenburrell Beds of the Onny Valley. The rocks bear a remarkably close resemblance to those of the Caradoc district but not to those of the Shelve Inlier, from which they are separated by an important structural line—the Linley–Pontesford Fault—and it is this fault-system rather than the Church Stretton fault-system which marks the most profound change in development of the Ordovician rocks in Salop (Dean 1964 : 37; *in* Williams *et al.* 1972 : 39).

Intrusive igneous rocks

Lapworth & Watts (1894 : 337–343) divided the igneous rocks of the Shelve Inlier into two groups, namely 'the interbedded andesitic ashes and lavas of Arenig and Bala ages and the intrusive dolerites and picrites'. The latter, both dykes and sills, were said to consist chiefly of hypersthene dolerite and were described as being of post-Llandovery age as they 'come into contact with and somewhat alter the *Pentamerus* limestones'. This last view, reiterated by Watts (1925 : 335), was subsequently shown by Whittard & Blyth (*in* Blyth 1944 : 178) to be untenable and the Shelve volcanics and intrusives are generally accepted as predating the local Upper Llandovery strata. In a very brief account Watts (1905: 177) noted that the Shelve vulcanicity occurred in two maxima (one of Arenig, one of Bala age) and that the rocks were 'almost exclusively andesites in the form of lavas and tuffs', some of which were said to be fossiliferous, having been deposited under marine conditions. The last stages of the vulcanicity were stated to have been 'marked by the intrusion of sills, laccolites and dykes, along surfaces of movement due to folding, faulting and torsion'. A later description by Watts (1925 : 341–343) placed the two principal volcanic outbursts in the Llanvirn (Stapeley Volcanic Member) and Caradoc (Hagley and Whittery Volcanic Members), and the water-deposited andesitic tuffs and ashes of the former were stated to have been 'invaded by massive sills of andesite and by dolerites of the Llanfawr type as well as by the normal type'.

The principal paper dealing with this aspect of the Shelve Inlier is that of Blyth (1944), who showed that the basic intrusions, ranging from picrite to alkali-rich andesite, formed a single co-magmatic suite having affinities with rocks of plateau-basalt or olivine-basalt type. Some of Blyth's work was carried out in collaboration with Whittard and the results of his mapping of the dolerites of Squilver Hill and Corndon Hill, as well as of several smaller intrusives and dykes, is evident in the present work, though some of the geological boundaries were subject to later, minor revision. Watts (1925 : 354; *in* Whittard 1931*a* : 340) had earlier expressed the view that the Corndon intrusion was 'a laccolite intruded along an anticline which has sagged in the middle', an interpretation modified slightly by Blyth (1944 : 178–183; see also Whittard 1952 : 164), who considered the rock to be 'a faulted phacolith' intruded into the crest of a pre-existing anticlinal axis and having a thickness not necessarily more than *c.* 200 ft (61 m).

Although almost all Whittard's notes on the igneous intrusives are confined to brief field observations, a somewhat longer section deals with the andesite of Lan Fawr (Map and Figs 23, p. 34; 24, p. 36). The outline of the andesite, which appears to show little petrological variation, was mapped in detail and a surprising feature is that the shales into which it is intruded are little altered, show no spotted condition, and are at the most only slightly indurated. This andesite therefore has less effect on the country rock than the Corndon dolerite and many of the minor doleritic intrusions, which convert the rock at least into an adinole. The other feature which emerged gradually during mapping is the post-faulting age of the andesite. No faulted outcrop of the andesite can be proved, and yet well-established faults in the local sedimentary rocks trend towards the andesite and might well emerge on the other side. If this claim is justified, and no other answer has been found to explain the outcrops of the sedimentary rocks, the intrusion of the andesites was probably almost the last phenomenon to occur in the Ordovician history of the inlier. Certainly dolerites were intruded along fault planes but some, such as that of Corndon, are evidently cut by faults. The dolerites may thus be claimed as approximately equivalent in age to most of the faulting, though sometimes slightly older and often slightly younger. The andesite, however, is unaffected by faulting and there is no known case where andesite and dolerite are in juxtaposition. Nevertheless, the Lan Fawr andesite is jointed, and in places shattered, by tectonic events of uncertain age but almost certainly pre-Upper Llandovery. Excluding tectonics, there is a certain amount of mineralization with galena and this mineralization may be the last Ordovician event of which we have any record, the intrusion of the andesite being the penultimate one.

Silurian rocks

The stratigraphy and distribution of the Llandovery rocks in South Salop were the subject of early researches by Whittard whose 1932 account gave maps and descriptions of the outcrops around the Shelve Inlier. A review by Ziegler *et al.* (1968 : 742) introduced three new lithostratigraphic names (Bog Quartzite, Venusbank Formation and Minsterley Formation) for Whittard's more generalized terms and claimed that their 'only major re-interpretation' of his work had been to connect the so-called 'Venusbank outlier' (Whittard 1932 : pl. 61A) with the large outcrops lying to the north in the Hope Valley. During his later mapping of the area Whittard had, in fact, come to the same conclusion and a revised boundary for these Silurian rocks at Venusbank was published by him (1955 : fig. 1) as part of an outline map of the Shelve Inlier which matches that of the present work (Fig. 15, p. 25), though he did not draw attention to the fact. A further minor modification, described on p. 272 of the manuscript notes, involved the outlier of Silurian rocks at Round Hill, 1900 ft (579 m) WSW of Tankerville Mine. The small area described originally by Whittard (1932: 878, fig. 2) was subsequently extended, particularly to the NW, and the revised boundary is shown in the Map.

The several outliers approximately centred on Ritton Farm (Fig. 22, p. 33) are difficult to map in detail and the indication of a particular outline is adduced from the abundance of flags of sandstone which are unmistakable. In some cases there may be no solid rock left as a cap to the hill, but the very presence of a marked hill composed of soft shale is indicative of a protective covering which is still retained or has been removed only recently.

Geological structure of the Shelve Inlier

Perhaps the most obvious structural features of the inlier are the Ritton Castle Syncline and, immediately to the west of it, the Shelve Anticline. The axes of both these folds run approximately NNE and in general the regional strike of the Ordovician members follows suit. The existence of these structures has long been appreciated and was noted by Lapworth & Watts (1894 : 314, 317) whose then unpublished map (used later *in* Pocock & Whitehead 1948 : pl. 11) shows them clearly. A later account by Watts (1925 : 343) stated: 'In addition to this folding [the syncline and anticline] the rock structures are often cut by faults, the more important of which are longitudinal but tend to swing across the strike'. He noted that 'combined folding and faulting has produced remarkable outcrops in the Stapeley Stage at Bromlow Callow and the Hagley Stage near Wotherton', and observed that the faults often coincided with dolerite and picrite intrusions or, in the case of small transverse faults, with mineral-bearing lodes.

Unfortunately the Whittard manuscript notes contain no comprehensive account of the geological structure, allusions to which are confined to a few scattered comments. However, some of Whittard's main conclusions were expressed in his *A geology of South Shropshire* (1952 : 185–189), in which paper he noted particularly the 'powerful northerly-trending tear-faults which were accompanied by complementary shears running not quite at right-angles to one another and each making an angle usually in excess of 45 degrees with the main tear-faults'. Whittard considered that his recognition of the tear faults (which may readily be seen in the Map) provided the main difference between his and earlier interpretations of the structure of the Inlier. Examination of his map shows that a few of the tear faults coincide approximately with less extensive dislocations shown on the map of Lapworth & Watts (*in* Pocock & Whitehead 1948 : pl. 11), and it is likely that the latter structures are the longitudinal faults noted by Watts in 1925 (see p. 62). The main folding and faulting were ascribed by Whittard (1952 : 186–187) to the Taconian Orogeny and are certainly of pre-Upper Llandovery age. As far as the Shelve Inlier is concerned, they are no older than the Soudleyan Stage of the Caradoc Series, and may well be post-Caradoc in view of the lack of evidence for disturbances of this magnitude up to the top of the Onnian Stage in southeast Salop.

One can really only confidently determine the northerly-trending tear fault pattern by being able to feel sure of the relative stratigraphical ages of beds of somewhat similar but not identical lithologies when they are brought into juxtaposition; for example, Aldress, Rorrington, Meadowtown and Betton Members and some beds of the Weston Member. Although by no means the same, their lithologies in small exposures may be similar enough to cause much indecision regarding which subdivision they belong to. Consequently knowledge of the faunal sequence was of great importance in confirming the lithostratigraphic assignment of many localities. The more obvious faults are the complementary shears because they run across the strike, displacing ridges formed of hard rocks, instead of running with the strike as do the major tear faults, in regions occupied by softer rocks. Without the aid of stratigraphic palaeontology the pattern of faults developed through shear might well not have been recognized, with regard to the dominant northerly-trending members.

A major feature of South Salop geology, emphasized by Whittard (1952 : 185) and reiterated in a later review by Dineley (1960 : 6), is the large number of unconformities, often of major proportions, which range in age from Pre-Cambrian to Mesozoic. These are particularly noticeable in the Caradoc district, some 7 miles (11·3 km) to the east, where beds of only Caradoc age are found, resting with profound unconformity upon Pre-Cambrian rocks and succeeded unconformably by Upper Llandovery strata. As far as the Shelve Inlier is concerned, however, few breaks are documented. Following the probably relatively small disconformable gap between the Stiperstones Member and Shineton Shales (the base of which is not seen here), the Ordovician succession continued virtually unbroken, except by periodic outbursts of volcanic activity, from the Lower Arenig Series to the Lower Soudleyan Stage of the Caradoc Series. The Ordovician rocks of the Caradoc district were deposited along the margin of the so-called Midland Block and were separated by the line of the Linley–Pontesford Fault from the subsiding region farther west in which the Shelve rocks were deposited and which was connected with other areas of marine deposition in southern Europe, including especially Bohemia.

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